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CONTENTS

ORIGINAL PAPERS
Flip-Prism Test for Vertical Phoria.
Jess B. Eskridge 415
A New Test for Binocular Refraction at the Near-Point Working Distance.
Edward Goodlaw 420
Guided Development of Perceptual Skill of Visual Space as a Factor in the Achievement of Primary Grade Children.
Brian J. Cox and Lionel R. Hambly 433
Aberrations of Contact Lenses.
Gerald Westheimer 445

CORRESPONDENCE
Reading Speed.
William H. Cooper 419

SPECIAL REPORT
How the Sense of Sight Serves Mankind by G. K. Goortovoy.
Israel Dvorine 449
A Model Clinical Program for Optometric Students.
Margaret Dowaliby 481

EDITORIAL
Academy Post-Graduate Courses at Chicago.
Carel C. Koch 464

TRANSACTIONS OF THE ACADEMY
Post-Graduate Courses of the American Academy of Optometry, Chicago, December 6, 7, 8, 1961, at the Drake Hotel.
V. J. Ellerbrock, et al. 466

ANNOUNCEMENT
The Ohio State University, Course in Glaucoma Detection 486

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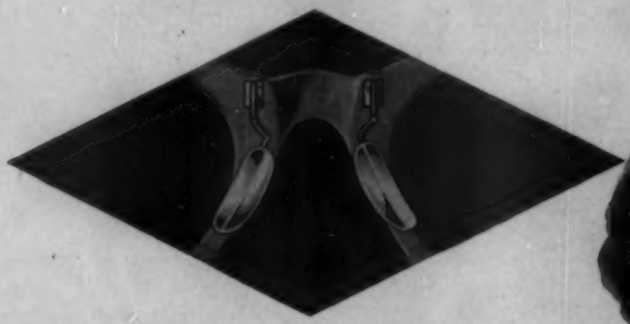

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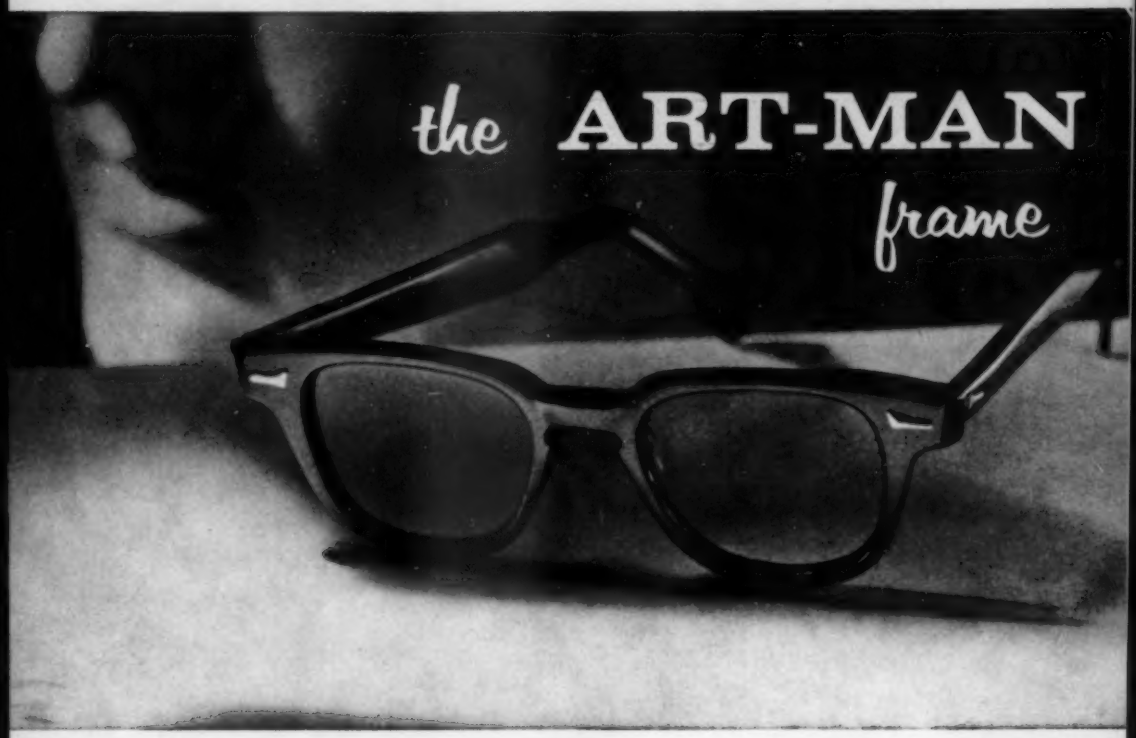

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Dr. Sheard was formerly editor of the *American Journal of Physiological Optics* and for many years director of the Department of Biophysics, The Mayo Foundation. The book contains 83 illustrations, 476 pages, $15.00.

CONTENTS

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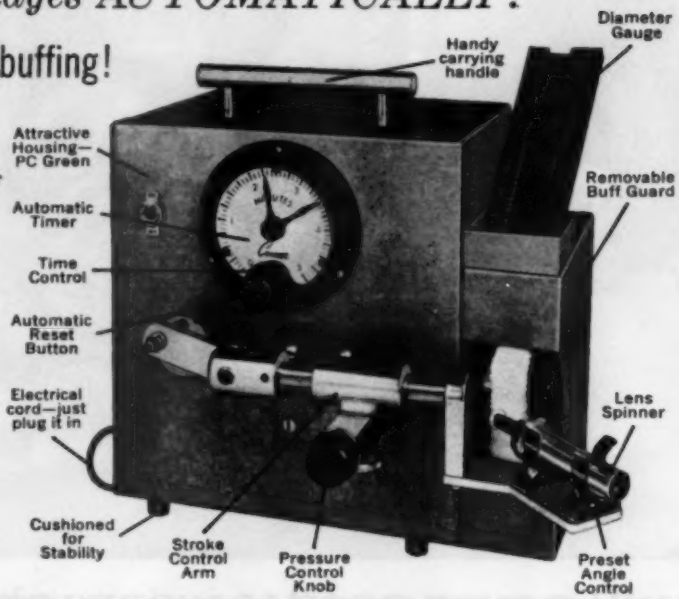

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Vol. 38 August, 1961 No. 8

FLIP-PRISM TEST FOR VERTICAL PHORIA*

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INTRODUCTION

One of the problems encountered by optometrists is the prescribing of precise prism corrections for vertical phorias, since few tests yield prism amounts which can be fully prescribed. The measurement of vertical phorias obtained with most tests is generally modified by some "rule-of-thumb" or intuition before the prescription is written. Elvin[1] lists some of the methods that have been recommended for modifying the measured vertical phoria in order to obtain the amount of the prescribed vertical prism correction. These methods include prescribing about two-thirds of the measured vertical deviation, prescribing the amount of vertical prism which allows the maximum horizontal fusional amplitude, prescribing the amount of the measured vertical deviation minus ½ Δ, prescribing the prism which balances the vertical vergences, or prescribing three-fourths of the vertical deviation measured with near fixation. Such arbitrary methods of determining the amount of the prescribed vertical prism can result in an inadequate correction. Morgan[2] and Elvin[1] have reported that they obtained good results—ocular comfort of the patient—when they prescribed the full vertical phoria correction measured with the Turville Test. This procedure, however, requires a special arrangement in the refraction room.

The purpose of this paper is to present a method of measuring vertical phorias which is not only mechanically simple and easy to perform, but one that yields prism amounts which can be fully prescribed, and also may indicate the presence of a latent vertical phoria.

EQUIPMENT

The equipment that is needed to perform this test includes a flip-prism, loose square prisms, and a small distance fixation target. The flip-prism is simply a 3Δ prism mounted in a lens cell with a long handle similar to a hand flip crossed-cylinder. See Figure 1. A

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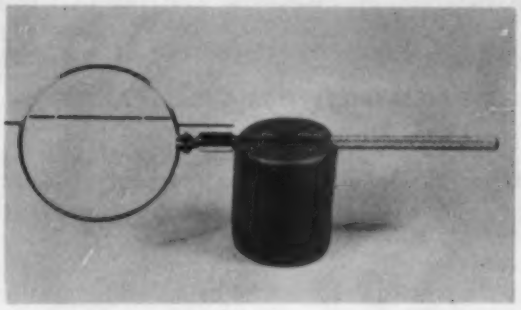


Fig. 1

small spot of light or a single 20/40 Snellen letter are convenient and adequate fixation targets.

METHOD

The patient should wear the new refractive correction in a trial frame, or his old correction in a conventional frame, if the change is not too great; he should be seated with his head and shoulders erect. A trial frame or conventional frame is used instead of the refractor so that the patient may hold his head in the usual position. With the head in this position, the effect of any existing head tilt on the vertical phoria, be it compensatory or otherwise, is included in the measurement and thus the normally present vertical phoria is determined. This is important, for as Giles[3] points out, vertical phoria can be corrected or reduced by a head tilt, and if a compensatory posture is normally present, the patient may not tolerate a vertical prism correction.

The patient fixates the distance target. The optometrist places the flip-prism base-down in front of the right eye, and asks the patient if he now sees two targets. Quickly he flips the flip-prism so that the base is up in front of the right eye, and again asks the patient if he sees two targets. If diplopia is present in either of the above, the following procedure can be used.

The patient fixates the target image that is seen with the left eye, and the flip-prism is placed base-down in front of the right eye. The flip-prism should be held with the face of the prism parallel to the patient's face plane and with the base-apex line coincident with the vertical meridian of the patient's right lens, so as to avoid erroneous results. The optometrist holds the flip-prism with the base down in front of the right eye for about two seconds and then flips the flip-prism so that the base is up in front of the right eye. He holds the flip-prism in this position for about two seconds and then flips it so that the base is down again. He continues this procedure, and asks the

patient to compare the vertical separation of the target images seen with the prism base down to that seen with the prism base up. The patient should be advised to ignore the horizontal separation and to concentrate only on the vertical separation.

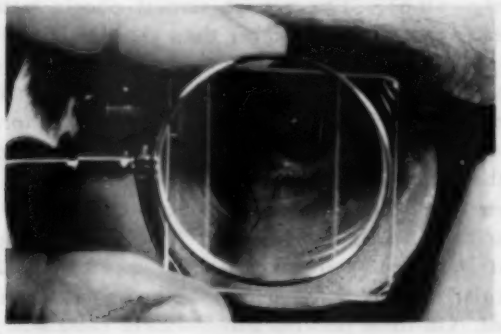
If the vertical separation of the target images is not the same with the prism base-down as it is with the prism base-up, the patient has a vertical phoria.

The direction of the vertical phoria is determined from the position of the base of the flip-prism when the flip-prism is in the position which produces the minimum vertical separation. If the base is down, a hyperphoria is present, and if the base is up a hypophoria is present. That is, if the patient sees the two targets closer together with the flip-prism base-down in front of the right eye, the patient has a right hyperphoria. Conversely, if the two target images are seen closer together with the flip-prism base-up in front of the right eye, the patient has a right hypophoria.

The amount of the vertical phoria is determined by using loose square hand prisms in conjunction with the flip-prism. A 1Δ loose prism is placed in front of the right eye with the base in the direction necessary to correct for the vertical phoria. The examiner holds the flip-prism in front of the right eye and repeats the flipping procedure described above. See Figure 2. He changes the amount of the loose prism until the vertical separation of the target images seen with the flip-prism base-down equals the vertical separation of the target images seen with the flip-prism base-up. The loose prism that produces this equality is a measure of the vertical phoria.

DISCUSSION

The sensitivity of this test is based on the patient's ability to detect the difference between the vertical separation of the two target



images seen in one instance to the separation seen a moment later. This might appear to be rather difficult and indicate that the test lacks sensitivity. It has been found, however, that untrained observers are capable of detecting the difference in separations which are produced by deviations of less than ½ Δ. This sensitivity is due to the fact that the testing procedure effectively doubles any existing vertical phoria, so that the vertical displacement of the target image resulting from the ocular deviation is more apparent to the observer. For example, if a patient has a ½ Δ right hyperphoria, and if single binocular vision is interrupted, the apparent vertical separation of the perceived images of a small spot of light at 6 meters resulting from this phoria would be 3 cm. With the 3Δ flip-prism base-down in front of the right eye, the apparent vertical separation would be 15 cm. With the flip-prism base-up in front of the right eye, the apparent vertical separation would be 21 cm. The difference between these two separations is 6 cm., double the amount that is present with the usual methods of dissociation. This 6 cm. difference at a distance of 6 meters is easily discernible.

As indicated earlier, Morgan and Elvin have obtained good results with the use of the Turville test. Good results have also been obtained by the author using the flip-prism test. To determine the relationship between the different methods of measurement, 30 vertical phoria patients were checked with the Von Graefe test, the Turville test, and the flip-prism test. The coefficient of correlation between the measurements with the Turville test and with the flip-prism test was +0.97. This indicates on the basis of Morgan's and Elvin's results that the prism amounts measured with the flip-prism test can be fully incorporated into the distance correction with good patient acceptance.

It is interesting to note that the coefficient of correlation between the measurements with the Von Graefe test and with the flip-prism test was only +0.61. The average vertical phoria measurement by the Von Graefe test was ½ Δ higher than those by the flip-prism test or Turville test. Loran[4] found similar results in that the vertical phorias measured in the presence of peripheral fusional stimuli (Turville test) were always less than those made in the absence of peripheral fusional stimuli (modified Von Graefe test). Here then is an apparent reason for one of the "rules-of-thumb" mentioned above.

In some cases, the target image appears to move or glide for as long as four to five seconds following the flip of the flip-prism. On such patients latent vertical phorias were suspected so these patients were monocularly occluded for at least 12 hours and the measurements were repeated. On those patients that indicated there was just as much

"gliding" of the target image following occlusion as before, no increase in vertical phoria was measured. However, on some of those patients reporting decreased "gliding" of the target image following occlusion, an increase in the vertical phoria was measured. Therefore, "gliding" of the target image may indicate latent vertical phoria, and such patients should be re-examined following a period of monocular occlusion.

REFERENCES

1. Elvin, Ferd T., The results of prescribing vertical prisms from the Turville test. Am. J. Optom. and Arch. Am. Acad. Optom., 31 (6): 308-314, 1954.
2. Morgan, Meredith W., Jr., The Turville infinity binocular balance test. Am. J. Optom. and Arch. Am. Acad. Optom., 26 (6): 231-239, 1949.
3. Giles, G. H., The Principles and Practice of Refraction. Philadelphia, Pa., Chilton Co., Book Division, 1960.
4. Loran, D. F. C., The effect of residual tonicity on the measurement of hyperphoria. Brit. J. Physiol. Optics, 17 (2): 64-88, 1960.

CORRESPONDENCE

READING SPEED

Aug. 3, 1961

To the Editor:

This is to acknowledge with gratitude receipt of the February 1957 number of your *American Journal of Optometry*, which contains Howard N. Walton's "Vision and Rapid Reading." It apparently has done little to affect the making or the accepting of continuing claims re 25,000 w.p.m. and the like, but—in the British phrase—it should do. Dr. Walton's findings, in any event, are not out of line with our experiences in working with certain high school and college students and adults; I especially like the quantitative precision of his maximum of 1,451.

DR. WILLIAM H. COOPER

READING LABORATORY, COLLEGE OF EDUCATION
OHIO UNIVERSITY, ATHENS, OHIO

A NEW TEST FOR BINOCULAR REFRACTION AT THE NEAR-POINT WORKING DISTANCE*

Edward Goodlaw†
Los Angeles, California

The Turville Infinity Balance Technique has been an outstanding contribution to our optometric armamentarium of distance tests.[1] Aside from providing a unique procedure of balancing visual acuity of each eye by changing lens powers before either while both eyes are performing binocularly, it is also possible to determine cylinder axis with greater accuracy and to observe the effect of fusion upon the cylinder axis. However, an even more important aspect of this test is the insight into the binocular ability of the patient which this test provides uniquely and conveniently. By providing nearly monocular central vision in a surround of binocular field it becomes readily possible to determine if the patient is seeing only one image, because he is using both eyes and fusing the image from his two eyes, or if the single vision is reported because he is seeing with only one eye and suppressing the other. Furthermore, the quality of this suppression or binocular fusion is readily apparent by the stability exhibited during the testing conditions. If only one row of letters can be seen even with the reduction of the intensity of stimulus before one eye by the introduction of filters of various absorption before the dominant eye, then we know that this patient has a strong tendency to use only one eye or may even be totally monocular. On the other hand, if one row of letters tend to "come in" and "fade out" we know that this patient is struggling between binocular and an escape into monocular vision.

All of this is obtained in a situation very nearly approximating actual seeing conditions. This is important because it gives an accurate estimate of the visual habits of the patient. Most other tests which try to accomplish this superimpose variables of the testing situation itself.

The attempt to label the image of one eye with color, by introducing a colored lens before one eye, reduces the intensity of the stimulus for that eye by virtue of the absorptive filter. It also introduces an impediment to fusion by the difference in color of the image of each eye. Introducing prism, to break fusion, so that the patient can compare the

*Read before the annual meeting of the American Academy of Optometry, San Francisco, California, December 11, 1960. For publication in the August, 1961, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.
†Optometrist. Fellow, American Academy of Optometry.

vision of each eye by comparing the two images, has the patient comparing two monocular fields. Fusion has been broken by the prism, and the situation under binocularity no longer prevails. This would also apply if anaglyph spectacles are used with correspondingly colored images or with polaroid filters before the eyes and correspondingly polarized targets.

Trying to analyze this binocularity-monocularity relationship in the "skill tests" with a stereoscope introduces many artificialities in the testing situation which influence the patients' responses. The patient is performing in a contradictory environment under these conditions. He knows the target is near and yet it is projected to optical infinity. The optics of the instrument magnifies the targets. There are peripheral fusion stimuli. Hence there is room for serious question whether some of the abnormal responses are due to the abnormalities of the binocular function as such or are occasioned by the use of the "boxing in" type of instrument.

Mention should be made of two other facets of the Turville infinity balance test. If the patient's attention is directed to a comparison of the vertical dimensions of the two fields on each side of the bar, a clue is provided for any aniseikonia in the 90° meridian. The other facet is the retinal slip method of prescribing prism. In viewing the visual acuity target split by the bar, a vertical phoria will manifest itself by the vertical displacement of one line of letters with respect to the other. The introduction of vertical prism to relevel the two rows of letters provides a good measure of the vertical prism required by the patient for comfort. The same procedure applies to the horizontal prism though in my experience the findings are not as precise in indicating the prism to be prescribed.

The very fact that this information is so readily available to the optometrist permits prescribing with a greater insight and confidence. However, this test is done at the distance—at the zero level of accommodation. In saying this I in no way wish to minimize its value, but there is even greater need for similar information at near. In relating the clinical data to the haploscopic data, Morgan[2] pointed out that "the generally accepted clinical tests for positive and negative relative accommodation are not valid as they are too high by some unpredictable amount. They can merely be used usually in a sort of indicative way and cannot be interpreted rigidly except under very special circumstances." According to Flom[3] when the stimulus to accommodation is changed as the convergence is held fixed, the haploscopic data show that the accommodation changes in an orderly way up to a certain limit

and then it no longer responds to the change in stimulus. It would help to know more accurately the points at which the deflection takes place in the orderly response of the accommodative mechanism.

Let us for the moment consider the positive and negative relative accommodation tests, the increasing negative lens to blur and the increasing positive lens to blur. This test is performed with good illumination while the patient is fixating small print on a white card. The card has a high reflectance character so that in the performance of this test much light is reflected back into the patient's eyes. Now, the normal response when the eye is subjected to illumination is the reduction in pupil size. When the pupil gets smaller, the depth of focus of the eye increases. But, in this test we are asking the patient to tell us when the target blurs as we change the stimulus to accommodation while maintaining convergence. By performing the test under conditions of increased depth of focus of the eye, we are decreasing the accuracy of the test.

There is a method that we can use which overcomes this source of error.

In working with patients with central or nuclear cataracts it is necessary to obtain the maximum dilation of the pupil to permit vision through clear areas of the crystalline lens. Clinically this can be accomplished by overlaying a black opaque sheet over his reading material with only a small cut out window through which the patient can see the words. The improved reading ability of these patients as their pupils enlarge, permitting the light to pass through the clear lens area, is testimony to the effectiveness of increasing the pupillary size by such a procedure. Obviously performing the plus and minus lens to blur test at near with a dark card with only a central light area for the seeing task improves the accuracy of response to the blur with the decreased depth of focus of the eye occasioned by the increased pupil size.

Thus by changing the visual environment of the target we have improved the accuracy. However, there is still more information we should like to have in our near findings which none of our tests provide. What kind of response does the patient make as we apply this plus and minus stress to his visual apparatus? As the plus lens power is increased, the convergence stimulated by accommodation is relaxed and the fusion ability is used to maintain single vision. Is the experienced blur due entirely to the inability of accommodation to relax further or is some of the target blur caused by the inability of the fusion mechanism to hold the two eyes in proper alignment? Does retinal slip occur? Is the patient actually seeing with both eyes as the blur sensation is approached, or

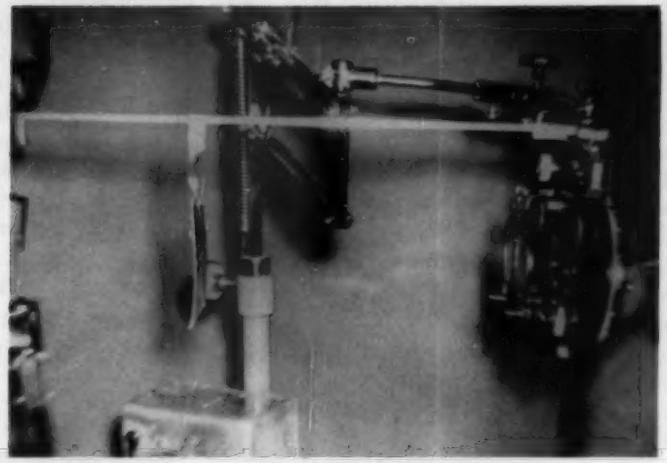


Fig. 1. Picture of the testing situation.

has he resorted to an escape to monocular vision under this stress by resorting to suppression?

Similarly, what is the nature of the patient's response as the minus is increased? Certainly a method which would supply this information quickly and simply could provide the kind of clinical insight into

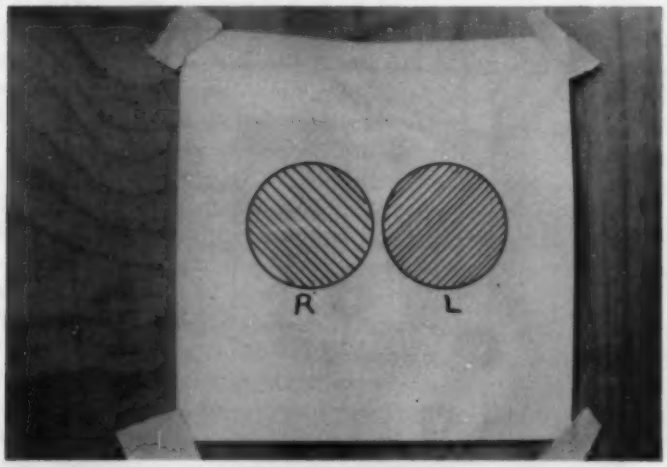


Fig. 2. The polaroid viewers placed over the patient's eyes.

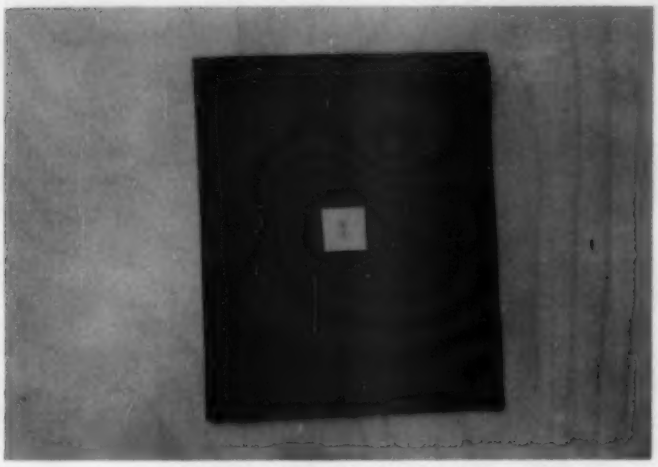


Fig. 3. Picture of the test card.

the patient's reaction to binocular stress as the Turville test provides in the distance testing. In fact, the information is even more valuable because in the near testing the response is to the plus, as well as the minus lens power deviation from the point of fixation, while the Turville test provides information at the zero level of accommodation. It

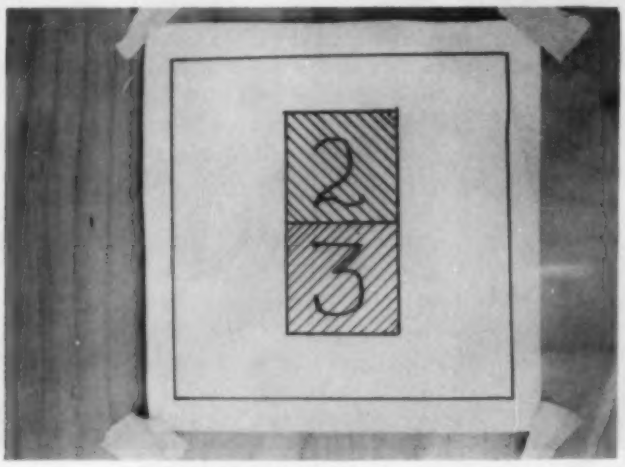


Fig. 4. An enlargement of the 10 mm. by 10 mm. cut out square in the test card.

is these considerations which have prompted the presentation of this new binocular test at the near working distance.

I shall now describe the new suggested testing procedure. The testing card, about 5" × 6" in size, is made of dull black opaque material. In the center, a small square opening is cut about 10 mm. by 10 mm. This opening is backed by a sheet of translucent tracing paper. In the center of this paper are inscribed two small numbers one placed directly above the other. The upper number is a 2 and the lower is a 3, subtending about 20/40 reduced snellen size. Covering these two numbers are cemented two small squares of polaroid filter material, about 3 mm. × 3 mm. It is understood, of course, that by virtue of the placement of the numbers under the polaroid, the two polaroid squares are in vertical alignment with the bottom of the upper square just touching the top of the lower square. The upper square is so cut that the axis of the polarization is at 45° while that of the lower is at 135°. Surrounding these polarized squares, and within the confines of the cut out square is the translucent white paper which is not polarized. This test card is then mounted on the arm of the refractor, about 40 cms. from the patient's eyes and centered with respect to the ocular apertures of the refractor.

Attached to the refractor, so as to cover the ocular apertures, is placed a polaroid viewer. The polaroid filters in the viewer are aligned so that the plane of polarization over the right eye is at 45° and the left is at 135°. (See Figures 1, 2, 3, 4.)

All lights are turned off in the room except for one light placed behind the test card so as to provide transmission through the translucent cut out square. In this way, both eyes see the black test card, the surrounding room and all of the translucent cut out square except that under the polaroid material. The small 2 under the upper polaroid square is seen only by the right eye while the small 3 under the lower polaroid square is seen by the patient's left eye.

It should be noted that ambient light upon the face of the test card is cut to a minimum, but the edges of the test card should be seen by the patient.

With this arrangement, base-in or base-out prism power with the Risley prisms on the refractor can be introduced and the optometrist may determine at just what point retinal slip occurs; when blur occurs, and when doubling occurs. It can also be determined if the patient resorts to suppression of one or the other near macular area as the prism stress is increased.

It has been the writer's experience, however, that if the patient can

see with both eyes when there is zero power before his eyes, he very rarely suppresses with added base-out or base-in prism power. Usually retinal slip occurs and finally doubling. The prism power necessary before retinal slip occurs does vary from one individual to another, but the results do not permit satisfactory interpretation at this time. There is also considerable variation between the prism power of first noticeable retinal slip and final doubling. The clinical significance of this also needs to be investigated more fully. Future investigation might profitably consider any possible relationship between first noticeable retinal slip as increasing prism power is added and the blur points obtained under the base-out to blur and base-in to blur of our usual clinical procedure with small print on a white card.

However, applying stress to the binocular mechanism with plus or minus lenses is quite a different story. For those patients where no suppression or doubling occurs in response to added plus or minus lens power under the test conditions, and only a blur of the target occurs, the range from blur with plus lenses to blur with minus lenses is much smaller than that found in the conventional positive and negative relative accommodation test with a white card. As discussed above, I believe this is a direct result of the increased pupil size induced by the technique used.

To illustrate this situation in which the addition of both plus and minus lenses results in the blurring of the letters of the target without suppression, the case record of patient A.F. is submitted. Age 45. This patient was examined October 1, 1960. He works as a mechanic in a bowling alley. His task is to maintain the automatic pin setting machines. His work entails some looking up at the underside of the machines while lying on his back. However, most of his work is looking downward at the machine parts held approximately at reading distance. Recently he has been bothered by blurring of both distance and near vision.

A.F.
Visual acuity without Rx.: O.D. 20/30 O.S. 20/30 O.U. 20/25
Cover test: Orthophoria
Convergence: Near point = 5", O.S. Out. Diplopia
Fixation reflex: Far to near O.K. Near to far O.K.
Versions showed slight restriction in the action field of R.S.R. & L.S.R.
Confrontation: Normal Fields O.U.
Anterior segment and Adnexa of both eyes appear free of pathology.
Posterior segment:
O.S. fundus a bit pale but otherwise normal
O.S. as O.D.—also free from pathology. PD. 69 = mm.
Ophthalmometer:
O.D. 44.75 sph.
O.S. 43.00 sph.

Static retinoscopy: O.D. -0.25×90 O.S. $-0.25 \bigcirc -0.25 \times 90$
Dynamic lag: O.D. +2.00 O.S. +2.25
Subjective:
O.D. $-0.25 \bigcirc -0.25 \times 90$ 20/20
O.S. $-0.25 \bigcirc -0.25 \times 90$ 20/20
T.I.B.—same 0 Hyper.
Phoria: ½ Eso 0 Hyper.
Monocular X Cylinder: O.D. +1.75 O.S. +1.75
Binocular X Cylinder: O.U. +1.75 At 45 cms.
Subjective at near +1.75
Accom. sup. conv.: −10/+1.75
Negative relative convergence: 25/15
Positive relative convergence: 12/4
Accommodative Amp. O.D. +1.25 D. O.S. +1.25 D.
Relative Negative Accommodations: +2.75
Positive Relative Accommodation: +0.25
Goodlaw Near Test:
+2.25 to blur out
+1.00 to blur out
Rx. prescribed:
O.D. $-0.25 \bigcirc -0.25 \times 90$
O.S. $-0.25 \bigcirc -0.25 \times 90$
Add +1.75 O.U.

As can be seen from the findings recorded, the conventional relative accommodation showed a range of +2.75 D. to +0.25 D., which is about 2.50 D. with the midpoint at +1.50 D. add. On the other hand, using the polaroid in the technique suggested here, the range was from +2.25 to +1.00, which is only 1.25 D. with the midpoint at +1.62 add. Both are in relatively good agreement with the add accepted by the cross cylinder, subjective at near, accommodative amplitude (leaving ½ in reserve we have a total accommodative amplitude of +1.25 divided by 2 equals 0.62; subtracting this from 2.50 D. required at 40 cms. we would need about +1.87 add) and the dynamic retinoscopy findings.

However, not all patients respond by reporting blurring of the target with the addition of plus or minus lenses in the near testing procedure suggested in this presentation. Some report a fading out of the numbers, indicating suppression. In these individuals the suppression points, or the moments of reversion to monocular vision could be taken for the recording of the data and the range is found to be about the same and the midpoint is indicated with the same accuracy. A fair number will show suppression in one eye with the addition of plus lens power, while the opposite eye will be suppressed with the addition of minus power.[4] An example of this type of response is shown in the case findings of Miss J.M. which follow:

Miss J.M. Age 20.
Visual acuity without Rx.: O.D. 20/100 O.S. 20/70 O.U. 20/70
Visual acuity with old Rx.: O.D. 20/40– O.S. 20/40 O.U. 20/40
Her old Rx. is: O. D. −0.25 D.S. O.S. −0.25 D.S.

Cover test: Slight exo
Convergence near point: 4" O.S. turns out, diplopia
Fixation reflex: Far to near O.K. Near to far O.K.
Versions: Showed no limitation in eye movements
Confrontation: Normal fields O.U.
Anterior segment and Adnexa:
O.D. Mild allergic conjunctival irritation
O.S. Same mild conjunctival irritation
Posterior segment:
O.D. Media are clear, fundus appears normal
O.S. Same as O.D.
P.D. = 61 mm.
Ophthalmometer:
O.D. 41.75 sph.
O.S. 41.25/180 41.50/90 −0.25 × 180
Static Retinoscopy:
O.D. $-0.25 \frown -0.25 \times 180$
O.S. $-0.25 \smile -0.25 \times 180$
Dynamic lag: O.D. +1.75 O.S. +1.75
Subjective:
O.D. $-0.75 \frown -0.25 \times 90$ 20/20 = 20/20
O.S. $-0.75 \frown -0.25 \times 90$ 20/20
T.I.B.: Same. 0 hyperphoria
Phoria: ½ esophoria ¼ left hyper.
Monocular cross cylinder: O.D. Uncertain O.S. Uncertain
Vision at 40 cms. clear and comfortable in distance Rx.
Accom. sup. conv. = 0 −5/+1.00
Negative relative convergence:
26/14/+1.00 27/10/P.R. Rx.
Positive relative convergence:
22/7/+1.00 14/7/PR. Rx.
Accommodative Amp.: O.D. +12.00 O.S. +12.00
Positive relative accommodation: −3.00
Negative relative accommodation: +2.25
Goodlaw near test:
Neg. suppresses: O.D. at +1.00
Pos. suppresses: O.S. at −1.50
Rx. prescribed:
O.D. $-0.75 \frown -0.25 \times 90$
O.S. $-0.75 \smile -0.25 \times 90$

J.M. is a senior student at U.C.L.A., majoring in psychology. Her previous spectacles, which were fitted to her about four years ago, no longer give her adequate vision in the distance. Objects in the distance are even more blurred without lenses. Without her spectacles vision is quite clear at near. If she persists in reading without spectacles her eyes begin to throb, so generally she tries to read with them. Even then she becomes uncomfortable. She finds she has to hold her reading material closer to her eyes than she would like for comfort. In J.M.'s findings the conventional N.R.A. and P.R.A. tests show a range of 5.25 D. with a midpoint of –0.37 over the subjective. With the suggested polaroid near test the range was 2.50 with the midpoint –0.25 over the subjective.

A third type of response can be seen in those individuals who

have a strong dominance of one eye and suppress the less preferred eye when the binocular stress becomes great enough. The case history of patient C.S. exhibits this character. This young lady is attending L.A.C.C. studying to be a dental assistant. She reports that her vision is fair in the distance but she is not comfortable at her near work. When she first starts to read the print is blurred. Concentrating, she finds that the letters seem to clear for a few moments and then they begin to swim and run together. Persisting in reading, her eyes begin to burn, lacrimate excessively, and she develops a headache. These headaches are primarily in the left temporal area. Its occurrence is definitely related to the amount of near work which she does. It is relieved by sleep. Her general health is good. About 3 years ago she had her eyes examined. Lenses were prescribed then. They seemed to help, but in about 6 months she lost them. Unfortunately, she then couldn't afford further care. Her findings are as follows:

C.S. Age 18.
Visual acuity without Rx.: O.D. 20/60 O.S. 20/40 O.U. 20/40
Cover test: Slight Exo.
Convergence near point = 6″, eyes alternate, she sees double
Fixation reflex: Far to near O.K. Near to far O.K.
Versions: Complete without evidence of any restrictions
Confrontations: Fields are normal
Anterior segment and adnexa are free of pathology
Posterior segment: O.D. Negative O.S. Negative
Ophthalmometer:
O.D. 43.25/45 44.25/135 −1.00 × 45 Cornea appears irregular
O.S. 43.50 Sph.
Static retinoscopy: O.D. −0.50 ⌒ −0.50 × 60 O.S. −0.50
Dynamic lag.: O.D. +1.75 O.S. +1.50
Subjective:
O.D. −0.25 ⌒ −0.50 × 60 20/20
O.S. −0.50 20/20
O.U. 20/20
T.I.B. same 0 hyperphoria
Phoria: Ortho. 0 hyperphoria
Monocular X cylinder: O.D. +0.50 O.S. +1.00
Binocular X cylinder: −0.50
Subjective at near: −0.25
Accom. sup. conv.: −12
Neg. relative convergence: 27/21
Pos. relative convergence: 20/0 18/2
Accommodative amplitude: O.D. +10.00 O.S. +10.00
Negative relative accommodation: +2.25
Positive relative accommodation: −7.75
Goodlaw near test:
Negative +1.25 suppresses O.D.
Positive −1.00 suppresses O.D.
Rx. prescribed:
O.D. −0.25 ⌒ −0.50 × 60
O.S. −0.50

The Goodlaw near test shows clearly why this patient exhibits such unusual findings in the conventional relative accommodative test.

In the positive phase, as the minus lens power was added she reverted to monocular vision with the left eye, so that in actuality, we were measuring the accommodative amplitude for the left eye only. Depending on the conventional relative accommodation test would have shown a range of 10.00 D. with a midpoint of –2.75 over the subjective, which would be totally wrong. The near test here under discussion disclosed a range of 2.25 D. with a midpoint of +0.12 over the subjective.

Finally there are a group of individuals who have a muscular anomoly and fusion problems, and these respond with intense suppressions regardless of lens power when the polaroid is placed over their eyes. This response is similar to the type of response they exhibit on the Turville test. Others of this type may show a combination of suppression which is fleeting, retinal slip, or diplopia which is not overcome unless prism is supplied.[2]

One of the important needs in our refractive procedure is to be able to determine which patient with a muscular anomaly will experience difficulty because of this anomaly at his near work. The elusive facet of tolerance of the given individual cannot be measured. However, to know the intensity of the binocular response or the facility of the escape into monocularity and suppression gives a better understanding of the fusion effort that will be expended to overcome the muscular anomaly disclosed in the accommodative supplementary convergence test as well as the positive and negative relative convergence tests.

The actual squinter whose prime complaint is cosmetic will exhibit only a monocular response with intense suppression of the nondominant eye in a test as sensitive as this. For the exotrope who can exhibit diplopia and who has ample accommodation this test offers the unique opportunity of permitting the addition of minus lens power, thereby stimulating accommodative convergence, till fusion occurs. In this way a good method is provided to actually measure the minus lens power necessary for fusion. In a similar manner the high esophore who needs plus lens power for fusion could be investigated with this test, provided he too can be coaxed into maintaining a binocular response. When to give orthoptics or when to leave well enough alone can be influenced by a better understanding of the binocularity vs. monocularity of the patient's response.

It is with these considerations in mind, therefore, that I have chosen a case history of one who had a slight convergence weakness that was amenable to orthoptic training. This history can illustrate characteristically the response of one with such an anomaly.

B.G. Age 43.
Visual acuity without Rx.: O.D. 20/40 O.S. 20/35 O.U. 20/30
Cover test: Slight Exo
Convergence near point: 5" right eye out, no diplopia
Fixation reflex: Near to far O.K. Far to near O.D. converges slowly
Versions: Slight restriction in action area of R.S.R.
Confrontation: Field of view appears normal in each eye
Anterior Segment:
O.D. Mild allergic conjunctival irritation
O.S. as O.D. Adnexa of both eyes normal
Posterior segment:
O.D. Light fundus but healthy and normal
O.S. Media also clear, no pathology
Ophthalmometer:
O.D. 44.25/180 45.00/90 −0.75 × 180
O.S. 44.25/180 45.00/90 −0.75 × 180
Static retinoscopy: O.D. −0.50 O.S. −0.25
Dynamic lag.: O.D. +2.00 O.S. +1.75
Subjective:
O.D. −0.50 20/20 −
O.U. 20/20
O.S. −0.50 20/20 −
T.I.B.: Same 0 hyperphoria
Phoria: Without correction 1 exo 0 hyperphoria
Cross cylinder (monocular):
O.D. +1.75 over the −0.50
O.S. +1.75 over subjective
Binocular cross cylinder: +1.50 over subjective
Subjective at near: +1.50 over subjective
Accom. sup. convergence: −8/no Rx. −10/+1.00
Negative relative convergence: 24/16/+1.00 24/16/no Rx.
Positive relative convergence: 0/−6/+1.00 6/−5/no Rx.
Accommodative amplitude: O.D. +2.00 O.S. +2.00
Negative relative accommodation: +3.00
Positive relative accommodation: −1.50
Goodlaw near test: Diplopia at first, then fusion with retinal slip momentarily and then suppression of right eye. Her old Rx. was +1.00 O.U. which we felt was adequate, and Rx. prescribed, base-out prism orthoptics.

Mrs. B.G. had spectacles for reading which were given to her about a year previously. While they made it possible for her to see her reading material clearly, when she read she became sleepy. Her eyes began to burn and lacrimate excessively and sometimes she developed a headache in the frontal area. In trying to work a crossword puzzle, she had special difficulty, because the squares seemed to swim and slide into each other. If she found herself in a situation in which there was movement around her, she became somewhat dizzy and even felt nausea. Her occupation was listed as housewife and part time secretary. She had no difficulty seeing distant objects.

With the conventionl relative accommodative test the range was 4.50 with the midpoint at +0.75 over no Rx., but the near test here presented immediately disclosed a fusion problem.

In summary then, I have discussed the Turville Infinity Balance technique, pointing out its unique value in disclosing quickly and effi-

ciently binocular balance at far as well as the binocularity versus monocularity of the patient's response. I have also pointed out the fact that this test is done at the zero level of accommodation, and the need for a test at the working distance which would supply similar information. Then I have suggested such a test at the working distance, described the construction of the materials used, and the method of applying it. I have discussed the information it supplies and how it integrates into the refractive routine. Finally, I have illustrated the various types of response with case histories.

I have found the technique of this binocular test at near an invaluable asset in my practice in understanding the visual problems of my patients. It is my hope that with this presentation this technique will find more universal acceptance so that optometry can do an even better job in providing good and efficient vision.

REFERENCES

1. Morgan, Meredith W., Jr., The Turville infinity binocular test. Am. J. Optom. and Arch. Am. Acad. Optom., 26 (6): 231-239, 1949.
2. Morgan, Meredith W., Jr., The clinical aspects of accommodation and convergence. 21 (8): 301-313, 1944.
3. Flom, Merton C., On the relationship between accommodation and accommodative convergence. Pt. 1. Linearity. Am. J. Optom. and Arch. Am. Acad. Optom., 37 (9): 474-482, 1960.
4. Carter, Darrell B., Studies of fixation disparity. Am. J. Optom. and Arch. Am. Acad. Optom., 34 (6): 320-329, 1957; 35 (11): 590-598, 1958; 37 (8): 408-419, 1960.

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ANNOUNCEMENT

CONTACT LENS CONGRESS

Dr. Leonard Bronstein, executive secretary of the National Eye Research Foundation, announced that the 6th National Contact Lens Congress would be held in Chicago at the Sherman Hotel, November 12-14, 1961. This schedule will allow for three full days of educational sessions. Authoritative speakers, both domestic and foreign, in the fields of optometry, ophthalmology and chemistry will lecture to those attending. Registration forms may be had by writing to the National Eye Research Foundation, 37 South Wabash Avenue, Chicago 3, Illinois.

GUIDED DEVELOPMENT OF PERCEPTUAL SKILL OF VISUAL SPACE AS A FACTOR IN THE ACHIEVEMENT OF PRIMARY GRADE CHILDREN*

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THE PROBLEM

From the great mass of literature on the relations of vision to scholastic achievement, the following generalizations can be made.

1. Gross, easily detected, eye defects which significantly distort vision are real obstacles to satisfactory learning, but the more common eye defects of lesser degree, such as small refractive errors or neuromuscular imbalances are (with individual exceptions of course) not real obstacles to satisfactory learning.[3, 4, 9, 10, 34]

2. When visual performance, rather than eye structure and function, is considered, many unobstrusive visual factors do seem to have considerable importance for learning. Investigations correlating the level of visual perceptive-motor skills or their trained improvement with scholastic achievement consistently show positive results.[5, 18, 19, 20, 25, 26, 27, 29, 31, 32, 33, 36, 43]

For the second of the above statements there is, as yet, insufficient follow-up: the relationship between the level of visual performance (and enhancement thereof) and ability to learn in school is presently too ill-defined to be well utilized. The problem herein is to clarify some aspects of this relationship.

RATIONALE AND PREVIOUS STUDIES

The correction of functional aberrations in basic human performance has been developed by a relatively new constellation of professional groups. That small gap between the services of the educational and the health professions has become a field in itself. Brueckner and Bond[7a] have recognized this in their term *psycho-educational procedures*. Specifically, where this marginal field concerns visual performance, failure to recognize and compensate for the gap in service appears to be retarding better visual care, if such care is intended to equip children for school learning tasks and for adult occupational tasks.

In dealing with the senses, the health professions endeavor to

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‡Optometrist. Now deceased.

establish or maintain normal structure and operation of the constituents of the sense organs, and presume that educationalists will teach the individual how best to use this apparatus. Yet, probably with the assumption that a child develops optimum performance in the use of his senses naturally and without guidance, educationalists proceed to teach manipulation of symbols and complex abstraction[12] which of course are absorbed according to perceptual ability.[15a]

More and more research evidence is showing that experience plays a vital role in the development of even the most fundamental and supposedly innate activities.[1c, 2, 14a, 15b, 21, 22, 23, 24, 28, 30, 37, 39] Similar evidence further shows that children often fail to develop adequate visual performance naturally. Gesell[11a] found that children seldom achieved the stable motor performance (visual) that is required for school learning before the age of eight years and often not until the age of ten or twelve—a few never attaining it despite normal sense organs. Lowenfeld,[27] by analysis of creative ability of primary grade children in drawing, showed that spatial organization affects learning, especially reading. He also found wide variation in the state of development of spatial organization of these children. Vernon[40] found visual skills of orientation (recognition of different positions of the same form) very limited in the primary grades.

Since the term *perceptive-motor skills of visual space* is not completely self explanatory, some definition is desirable: Visual perceptive skills may be divided roughly into two groups, the first having some element of space, the second having none. For example, the perception of the size of a flat figure involves space, whereas the perception of headlight glare need not involve space, only brightness or chroma. Though the perception of brightness or chroma is probably equally amenable to training, the present study considers training of only the spatial skills—those which imply perception of orientation of the body and its appendages relative to environment, and conjures up pattern, direction, distance, height, depth, size and shape.[16a] All such skills of perception involve a motor response, whether it be a movement of hand, eye or body, overt or merely ideated. This concept is supported by the work of Hebb[17] in respect to form perception which he found to be learned by exploratory eye movement (scanning).

The perceptual nature of motor responses completely rejects the precept that agility in playing a piano is an outward indication of the refinement of physiologic factors or nerve and muscle performance. In the same manner it rejects the precept that smooth regular eye movements in casual reading are an outward sign of high efficiency of extra-

ocular musculature.[16b] Instead the hyphenated term *perceptive-motor* is intended to suggest that any motor efficiency is manifested by accurate and facile perception of orientation of the body with respect to stimulus objects. Perceptive-motor skills are meaningful performances, not complex reflexes.[14b]

In fact Walls[42] has concluded that no amount of training or environmental influence can change, in any way, the visual apparatus in its totality from the retina to area 17 of occipital cortex. Thus refinement of seeing cannot be through conditioned reflexes but must be only through the higher elaboration of perception.

The idea of developing basic perceptual skills is not at odds with our present theories of learning: Allport[1b] has stated, "From the standpoint of field or cognitive learning theories it may be said that perception is a necessary aspect of learning itself. Indeed it might almost be said that learning *is* perception." The cognitive theory postulates that learning comes through meaning and purpose for basic survival and for pleasure drives. Learning by this means is instantaneous on meaningful factors whereas learning is ineffective on non-meaningful factors. On the other hand, the behavioral theory of learning-by-doing or practice-makes-perfect (development of habits) is thought to be gradual.[1a] This study's proposed development of perceptual skills by repeating meaningful practice tasks is acceptable to both theories.

Of course there is no point to trained improvement of perception unless there is transfer—transfer to school learning. There is evidence of such transfer: in fact the evidence points to a limited number of special basic skills of perceiving and acting which have general application in compounding all complex human skills.[15c] Many educationalists are beginning to subscribe to this idea and their views are the germinal thought of this study. According to Tallman,[38] "Vision and audition are achievements as well as gifts. The power of the eyes to see and the ears to hear can be developed. This is an educative process—. In any event, the school superintendent will need to incorporate into the educational procedures those materials and practices which will develop processes of seeing and hearing to their optimum potential."

Spencer[8] says, "Many pupils, even though they possess normal healthy eyes, need to learn how to use them efficiently for ordinary seeing. . . . Vision is not an inheritance and not a natural resource, but a product of growth and development. We acquire vision through experience in using our eyes . . . we learn to see; consequently, seeing becomes a problem of education."

NULL HYPOTHESIS

The controlled organization of experience in the perceptual-motor skills of visual space in 24 half hour training sessions over a period of three months for school children of the primary grades who are under 0.96 in achievement quotient will not cause a significant change in this same achievement quotient six months or more after completion of experimental training.

EXPERIMENT DESIGN

In British Columbia School District #35 (Langley) six elementary schools were initially selected for the location of the study. These schools were selected on the basis of working space available and the size of the Grade Two-Grade Three enrollment. The children of these schools, some rural and some urban, who were in Grade Two or Three in September, 1958 (with a few Grade One repeaters) were tested on the Primary, Form J (Grade Two) or Elementary Form N (Grade Three) of the Stanford Achievement Test and also tested on the Primary Short Form of the California Test of Mental Maturity or the Otis Alpha Test. From their scores on the above tests the children were assigned an achievement quotient[7b] (ratio of achievement age to mental age). Children with a quotient of 0.95 or lower were given a series of tests of perceptive-motor skills of visual space, namely:

1. Binocular rotary pursuits.
2. Cheiroscope tracing.
3. Stereopsis (Keystone D.C. series).
4. Near point of convergence.
5. Children's visual achievement forms.[26]

Detailed description, with scoring criteria, appears in a previous study by Cox and Stewart[9] for all but the last of the above tests. Children failing any one or more of these five tests were candidates for the experimental group to be given skills training aimed at building their performance. For technical reasons an equal number of children from the total number of candidates in any school were randomly placed

TABLE I. FORMATION OF GROUPS

School	Group A	Group B
1. A.L.	10	10
2. L.C.	14	14
3. O.	9	9
4. M.	7	7
5. G.	9	9
6. W.L.	14	14
Total	63	63

Figures indicate number of children placed in Group A or B from each of six schools.

in experimental or control groups rather than in matched pairs. The experimental group was called Group A and the control, Group B. This procedure made the groups quite diversified on many learning factors, so that it was necessary to measure changes in achievement in gains or losses over pre-experimental scores. For the same reason the achievement quotient measure was used instead of grade score measure.

The visual skills problems commonly found among the subjects in Table I could be classified in two main categories. About 80 per cent of the subjects had problems of essentially monocular motor control usually manifested by failure on the rotary pursuits test: 20 per cent had problems of essentially binocular coordination usually manifested by failure on the cheiroscope tracing test. About 30 per cent had both types of problem. The 126 children with visual problems were selected from a gross enrollment in Grades II and III (for the six schools) of 320.

The children placed in the A and B groups had two things in common. First by the ratio of their scores on a group intelligence test and a standardized achievement test, they all demonstrated an educational quotient of 0.95 or less. This means they were scholastically under-functioning in terms of their individual potential. Their actual I.Q. scores ranged from 58 to 150 with a median of 107 indicating that half of the subjects had normal or above normal scholastic aptitude and may have been achieving at or above their age-grade norm but below their own potential. Secondly, the children in the sample all failed one or more of the tests of visual perceptive-motor skills. Thus they were a group of primary grade children with at least one full year's school experience, with mental abilities comparable to the general population, with scholastic achievement below their mental age norm and with visual performance below standards arbitrarily set by the testing battery.

In order to eliminate children with uncorrected eye defects, all children tested on the perceptive-motor skills battery were previously given an eye defect screening test which included static retinoscopy, Hirshberg corneal reflex test, Snellen visual acuity and external observation of ocular adnexa and optical media. Children suspected of defects according to Orinda[6] standards were not included in the experiment, so that the children in the test sample had poor visual performance but normal healthy eyes free of defects or with defects adequately corrected by spectacles.

Children of Group A were taken out of their regular classes for a period of 30 to 40 minutes twice weekly for three months. At these

times they attended, at a special room in the school, training sessions for the development of perceptive-motor skills of visual space. These sessions were conducted by the author and are further described in the next section.

Three months after completion of experimental training (six months after commencement of the project) all the children of both A and B groups were retested on the original battery of visual performance tests and two months later were retested on a different form of the Stanford Achievement Test. The entire retesting was repeated a year later.

2. Experimental Variable

The following skills tasks were presented and trained approximately in the listed order.

(a) For developing perception of direction
- (1) flashlight fixations
- (2) straight line pursuits
- (3) rotary pursuits

(b) For developing perception of form
- (1) form puzzles
- (2) Lyon's tachistoscope slides

(c) For developing perception of distance—binocular parallax
- (1) control of binocular parallax
- (2) Brock string technique
- (3) Brock ring technique (near point modification)
- (4) cheiroscope tracing

In general each child was required to achieve satisfactory performance on one technique before moving on to the next. This allowed children to work at their individual rates and motivated their progress. However, it also meant that some of the children did not complete the full list of techniques. Detailed description of these procedures together with required standard of performance is to be found in a previous study by Cox and Stewart.[9]

RESULTS

By June, 1960, 18 months after commencement of the study only 55 of the original subjects were still available for testing in each group. Table II shows the number of children originally failing each of the visual performance pretests. Tables III, IV, and V show what changes occurred for the children failing the first three factors listed in Table II. The number of children failing the near point of convergence test and the children's visual achievement forms was considered too small for further analysis.

TABLE II. VISUAL PERFORMANCE FAILURES

Test Factor	Group A	Group B
1. Rotary pursuits	42	39
2. Cheiroscope tracing	17	15
3. Stereopsis	29	20
4. Near point of convergence	7	4
5. C.V.A. forms	10	2

Figures indicate number of children failing the September, 1958, pretest and still available for testing.

TABLE III. ROTARY PURSUITS IMPROVEMENT

	—Group A—		—Group B—	
Date	Pass	Fail	Pass	Fail
Sept., 1958	0	42	0	39
June, 1959	32	10	17	22
June, 1960	35	7	27	12

Figures indicate number of children passing or failing on the pretest and the two post-tests.

TABLE IV. CHEIROSCOPE TRACING IMPROVEMENT

	—Group A—		—Group B—	
Date	Pass	Fail	Pass	Fail
Sept., 1958	0	17	0	17
June, 1959	11	6	0	17
June, 1960	12	5	5	11

Figures indicate number of children passing or failing on the pre-test and two post-tests.

TABLE V. IMPROVEMENT IN STEREOPSIS

	—Group A—		—Group B—	
Date	Pass	Fail	Pass	Fail
Sept., 1958	0	29	0	20
June, 1959	3	26	3	17
June, 1960	20	9	9	11

Number of children passing or failing the Keystone D.C. Stereopsis Series (31-53) on the pre-test and the two post-tests. At least 40% rating was required for pass.

For the change of Group A in Table III from Sept., 1958, to June, 1959, χ^2 is 48+ therefore P is less than 0.001. At the same time for Group B χ^2 is 19+ therefore P is less than 0.001. This calculated from formula

$$\chi^2 = \frac{N\left(AD - BC - \frac{N}{2}\right)^2}{(A+B)\ (C+D)\ (A+C)\ (B+D)}$$

from Siegel[33a] and indicates that the improvement in both groups is significant at the 1 per cent level. However, when the two groups are analyzed Group A shows the superior gain, significant at 1 per cent level for which χ^2 is 8.26 therefore P is less than 0.01.

The 1960 results, more than a year after completion of special training, shows no regression for Group A; in fact there is continued improvement for both groups with B showing the larger gain such

that Group A is no longer superior because, for the 1960 difference between A and B, χ^2 is only 1.52, therefore P is more than 0.05.

For the change of Group A in Table IV from Sept., 1958, to June, 1959, χ^2 is 11+; therefore P is less than 0.001. For Group B during the same period there was obviously no improvement. Group A, up to June, 1959, is superior to Group B at the 1 per cent level of significance. However by June, 1960, Group B did show improvement significant at 5 per cent level, for which the Fisher[3,5b] exact probability is less than 0.05. Even so Group A was still superior to Group B (χ^2 is 4.25 therefore P is less than 0.05).

Table V shows that neither group improved from Sept., 1958, to June, 1959, in spite of special treatment given Group A. For the change in Group A from Sept., 1958, to June, 1960, χ^2 is 18+, therefore P is less than 0.001. On the second post-test Group B also improved (χ^2 is 7.5 therefore P is less than 0.01). The relative standing of groups at June, 1960, shows that A is not necessarily superior to B, because χ^2 is only 1.91 therefore P is greater than 0.05.

Reviewing the statistical analysis of these changes in visual performance we conclude that improvement in visual performance occurred in both the experimental Group A and in the control Group B. However, the improvement for Group A was for the most part significantly greater and was accomplished more quickly. Specifically in the Rotary pursuits, Group A showed improvement superior to Group B three months after special training (for Group A only) was completed. However, a year later Group B had caught up to Group A so that no significant difference existed between the improvement of the two groups. For Cheiroscope tracing Group A remained superior to Group B through June, 1959, and June, 1960, although Group B showed some delayed but significant improvement. Quite a different situation exists for the Stereopsis skill: Here the special training seemed to have no effect, because both groups slowly developed significant improvement by June, 1960. At no time was the improvement of one group significantly superior to the other.

In order to determine what effect successful perceptual skills training has upon academic performance, subjects of Group A who moved from a Fail to a Pass standing on the visual performance tests had their changes in learning pattern compared with that of control subjects of Group B who originally failed the same visual performance pre-test. Here it was necessary to compare an equal number of experimental and control subjects from any given school even though the total representation from the different schools remained unequal rela-

tive basic enrollment differences. Because the basic concern was with what visual performance training does to a child's manifest rate of learning, changes in achievement quotient were the measuring device. A positive increase in this quotient was considered an increase in learning rate, while no change or a decrease in the quotient was considered no change in rate of learning.

Table VI indicates that the trained improvement of visual performance increases rate of learning only when the skills improved are three binocular parallax-vergence skills, namely, Cheiroscope tracing, stereopsis and near point of convergence. Yet improvement on any *one* of these three did not significantly increase rate of learning.

TABLE VI. ACHIEVEMENT QUOTIENT CHANGES

Factor (See details below)	Group	A.Q. Up	A.Q. Not Up	χ^2	P
1.	A	29	26	low	high
	B	31	24		
2.	A	21	10	low	high
	B	18	13		
3.	A	13	8	4.76	0.04
	B	5	16		
4.	A	18	14	low	high
	B	18	14		
5.	A	8	5	low	high
	B	7	6		
6.	A	7	4	low	high
	B	4	7		

Figures indicate the number of children showing an increase or no increase in achievement quotient from Sept., 1958, to May, 1960. P is the probability that the difference is a chance one.

Factor #1: All of Group A compared to all of Group B.

Factor #2: Group A initially failing at least one visual performance test and now passing all 5 compared with Group B subjects initially failing at least one of the same tests.

Factor #3: Group A subjects initially failing at least one of Cheiroscope tracing, stereopsis and near point of convergence and now passing all three compared with Group B subjects initially failing at least one of the same tests.

Factor #4: Group A subjects initially failing rotary pursuits but now passing compared with Group B subjects initially failing the same test.

Factor #5: Group A subjects initially failing Cheiroscope tracing but now passing compared with Group B subjects initially failing the same test.

Factor #6: Group A subjects initially failing stereopsis but now passing compared with Group B subjects initially failing the same test.

CONCLUSION

If we are willing to accept the 5 per cent level of significance, the null hypothesis can be rejected when the visual performance factor improved is that measured collectively by cheiroscope tracing, stereopsis and near point of convergence. Certainly there is no evidence herein

that the improvement of any other individual visual skill or any other combination of such skills has any effect on rate of learning.

SPECULATIONS

Longitudinal cause and effect studies, though infinitely more difficult to design and operate, have considerable advantage over transverse correlation studies. In the matter at hand previous correlation studies indicated that a group of essentially monocular visual motor skills and a group of essentially binocular coordination skills were both important visual prerequisites for desirable school learning. The present study has indicated that improvement of certain binocular, but not certain monocular visual skills, may increase learning efficiency. Also transverse correlation studies could not have revealed the effects of time. Obviously maturation is a major factor in the improved visual performance of primary grade children particularly on essentially monocular visual motor skills.

All the above findings have some validity only for the population the sample group represents (which means only under functioning primary grade children). We must remember that many children studied here were achieving well above their grade norm but still under their mental age. Also while children are growing and changing so rapidly one must be cautious about extrapolating from one age level to another.

The change in achievement quotient produced by trained improvement of certain of the binocular skills is statistically significant at the 5 per cent level which, in the author's opinion, is not definite enough for any generalization. However, the results certainly encourage further investigation of these same binocular skills. Perhaps it would be fruitful to study the improvement of these skills for children performing below the grade norm.

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REFERENCES

1. Allport, Floyd H., Theories of Perception and the Concept of Structure. New York, N. Y., John Wiley & Sons, 1955.
1a. Page 439.
1b. Page 445.
1c. Page 648.
2. Bartley, S. Howard, Principles of Perception. New York, N. Y., Harper and Bros., 1958, p. 298.
3. Bender, Irving E., Henry A. Imus, John W. M. Rothney, Camilla Kemple, and Mary R. England, Motivation and Visual Factors: Individual Studies of College Students. Hanover, N. H., Dartmouth College, 1942.
4. Betts, Emmett A., and Agnes Sutton Austin, Visual Problems of School Children (reprinted from the Optom. Weekly). Chicago, Ill., Professional Press, 1941.

5. Bledsoe. Joseph Cullie. An Analysis of the Relation of Auditory and Visual Defects in School Achievement and Other Factors (Unpublished Master's Degree Paper. University of Georgia). 1940.
6. Blum. Henrik. Henry B. Peters. and Jerome W. Bettman. Vision Screening for Elementary Schools: the Orinda Study. Berkeley. Calif.. University of California Press. 1959.
7. Brueckner. L. J.. and G. L. Bond. The Diagnosis and Treatment of Learning Difficulties. New York. N. Y.. Appleton-Century-Crofts. Inc.. 1955.
7a. Page 412.
7b. Page 26.
8. Burton. William H.. Clara Belle Baker. and Grace K. Kemp. Reading in Child Development. Indianapolis. Ind.. Bobbs-Merrill Co.. 1956. p. 141.
9. Cox. Brian J.. and Colin Stewart. The effect of certain specific factors in optometric care upon the scholastic performance of underfunctioning students in junior high school in their response to remedial teaching. Canadian J. Optom.. 20 (2): 31-46. 1957-58.
10. Dalton. M. M.. A visual survey of 5.000 school children. J. Educ. Research. 37: 81-94. 1943.
11. Gesell. Arnold. Frances L. Ilg. and Glenna E. Bullis. Vision. Its Development in Infant and Child. New York. N. Y.. Paul B. Hoeber. Inc.. 1950.
11a. Pages 288-291.
11b. Pages 305-320.
12. Getman. G. N.. How to Develop Your Child's Intelligence. Rev. ed. Luverne. Minn.. Copyright by the Author. 1958. p. 19.
13. Gibson. James J.. The Perception of the Visual World. Boston. Mass.. Houghton Mifflin Co.. 1950. pp. 226-227.
14. Goldstein. Kurt. The Organism. New York. N. Y.. American Book Co.. 1939.
14a. Pages 175-183.
14b. Chapter 5.
15. Halstead. Ward Campbell. Brain and Intelligence. Chicago. Ill.. University of Chicago Press. 1947.
15a. Page 15.
15b. Pages 43-53. 88.
15c. Pages 87-88.
16. Harmon. Darell Boyd. Notes on a Dynamic Theory of Vision. Vol. 1. 3d ed. Austin. Tex.. Published by the Author. 1958.
16a. Foreword.
16b. Pages 30-31.
17. Hebb. Donald O.. Organization of Behavior. New York. N. Y.. John Wiley and Sons. 1949. pp. 80-90.
18. Hutchinson. H. J.. The Diagnosis and Treatment of Orthoptic Difficulties in Relation to Reading (Unpublished Master's thesis. Iowa State University). 1939.
19. Ilg. Vivienne. and Louise F. Davis. Visual patterns and school learning. *in* Optometric Annual. 2d ed. Chicago. Ill.. Professional Press. 1955. pp. 154-161.
20. Kelley. Charles R.. Visual Screening and Child Development. Raleigh. N. C.. North Carolina State College. Department of Psychology. School of Education. 1957.
21. Kephart. N. C.. Lectures. *in* Northwest Congress of Optometry. Dec. 12-14. 1954 (transcript). Portland. Ore.. Reporter Company. 1954. pp. 40-68.
22. Kephart. N. C.. Visual behavior of the retarded child. Am. J. Optom.. 35 (3): 125-133. 1958.
23. Kephart. N. C.. Optometry. Psychology and Education: a Series. Duncan. Okla.. Optometric Extension Program. Vol. 1. No. 1. Oct.. 1956. pp. 1-2.
24. Kephart. N. C.. Vision and the Retarded Child: a Series. Duncan. Okla.. Optometric Extension Program. Vol. 1. No. 2. Nov.. 1955. p. 5; No. 3. Dec.. 1955. p. 9.
25. Kephart. N. C.. Leo Manas. and Dorothy Simpson. Vision and achievement in kindergarten. Am. J. Optom. and Arch. Am. Acad. Optom.. 37 (1): 36-39. 1960.
26. Lowder. Robert Glenn. Perceptual Ability and School Achievement (Unpublished Doctoral Dissertation. Purdue University). 1956.

27. Lowenfeld, V., Creative and Mental Growth. New York, N. Y., Macmillan Co., 1942, Chapter 3.
28. Lyons, C. V., and Emily Bradley Lyons. The power of visual training as measured in factors of intelligence. J. Am. Optom. Assn., 26 (5): 255-262. 1954-55.
29. Olson, Howard C., Charles C. Mitchell, and William C. Westberg. The relationship between visual training and reading and academic improvement. Am. J. Optom. and Arch. Am. Acad. Optom., 30 (1): 3-13. 1953.
30. Pronko, N. H., What has psychology to do with optometry? Optom. Weekly. 46 (33): 1355-1360. 1955.
31. Robinson, Helen M., *editor*, Clinical Studies in Reading. II. With Emphasis on Vision Problems. Chicago, Ill., University of Chicago Press, 1953, pp. 60, 75, 111.
32. Roslow, S., Reading readiness and achievement in Grade One. J. Exper. Educ., Dec., 1940.
33. Russell, L., A study of the relationship between reading achievement and creative expression. Research Bull. Eastern Art Assn., 1 (1), 1950.
34. Sabatini, Raoul W., Abnormal vision and learning difficulty. Optom. Weekly. 43 (29): 1165-1169, 1952.
35. Siegel, Sidney, Nonparametric Statistics for the Behavioral Sciences. New York, N. Y., McGraw-Hill Book Co., 1956.
35a. Page 107.
35b. Page 95.
36. Sherman, R. A., An approach to personnel problems through visual performance tests. Am. J. Optom. and Arch. Am. Acad. Optom., 28 (2): 92-95, 1951.
37. Strauss, A. A., and N. C. Kephart, Psychopathology and Education of the Brain-injured Child. Vol. 2. Progress in Theory and Clinic. New York, N. Y., Grune and Stratton, 1955, pp. 61-71.
38. Tallman, Norman O., The administration of aural and visual reading, *in* Claremont College Reading Conference 18th Yearbook. Claremont, Calif., Claremont College Curriculum Laboratory, 1953, pp. 82-93.
39. Thompson, William R., and Woodburn Heron, The effects of restricting early experience on the problem-solving capacity of dogs. Canadian J. Psych., 8: 17-31, 1954.
40. Vernon, M. D., A Further Study of Visual Perception. London, Cambridge University Press, 1952, p. 116.
41. Visual Training at Work, Vol. 1-8. Duncan, Okla., Optometric Extension Program, 1942-1960.
42. Walls, Gordon L., The problem of visual direction. Am. J. Optom. and Arch. Am. Acad. Optom., 28 (2): 55-83; (3): 115-146; (4): 173-212, 1951.
43. Worcester, D. A., The influence of orthoptic training on the reading ability of college freshmen. J. Exper. Educ., 9: 167-174, 1940.

ABERRATIONS OF CONTACT LENSES*

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Aberrations of a visual aid can only be discussed in the context of the use of the device in association with the eyes. For example, in the case of spectacle lenses spherical aberration and coma do not play an important role because the bundle of light entering the pupil is usually small compared to the curvature of such lenses. On the other hand, since the eye moves with respect to a spectacle lens, oblique astigmatism, distortion and curvature of field need to be studied.

In contrast to this, contact lenses move with the eye and, since the sensitivity of the peripheral retina is limited, extra-axial imagery does not have to be of the highest quality. As a consequence, coma, oblique astigmatism, distortion and curvature of field are not highly significant aberrations of contact lenses so long as the lenses stay centered on the pupil. Spherical aberration, however, does have to be studied because contact lenses have relatively high curvature for their apertures.

The problem of chromatic aberration does not differ in the two kinds of correction and can be neglected.

For contact lens corrections there is the additional problem that general statements concerning the effect of spherical aberration of a contact lens on the quality of the retinal image cannot be made because a contact lens correction modifies to a large extent the optical properties of the cornea. Even where the spherical aberration of a contact lens is known, the effect on the retinal image of wearing such a lens cannot be fully predicted without a good deal of information about the corneal configuration of a given eye.

In this paper the discussion will be limited to the spherical aberration of contact lenses in air. This is an important preliminary step in the evaluation of the influence of contact lens aberration on vision in a given eye, but it is of interest also in connection with contact lens manufacture and measurement.

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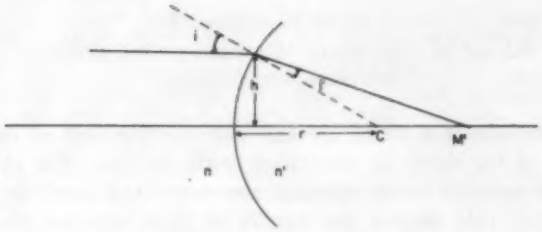

Fig. 1. Ray at a single surface. For description of symbols, see text.

Consider a surface (Figure 1) of radius r, separating a medium of refractive index n' from one of n, and regard the line passing through C, the center of curvature of the surface, as the axis. Any other ray, coplanar with this axis, such as the one indicated in the figure, will be deviated at the surface and will intersect the axis at a point M'. The position of M' will depend on the characteristics of the surface (n, n', r) and on the inclination of the ray with the axis and its height, h, upon incidence at the surface. The distance of M' from the pole of the surface can be computed exactly by applying Snell's law ($n \sin i = n' \sin i'$). For a given wavelength of light, it can be calculated precisely without any approximations.

In the more usual application of contact lenses, the observing point is at infinity and all incident rays can be considered as parallel to the axis (Figure 2). These rays will be deviated by the first surface of the contact lens according to its characteristics (refractive index

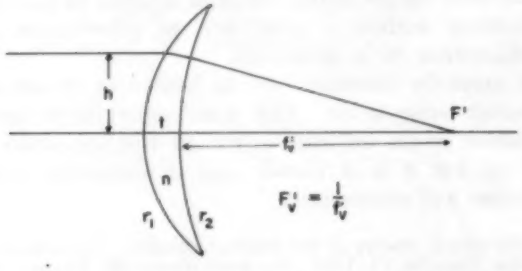

Fig. 2. Ray parallel to axis incident at a height h on the first surface of a contact lens is deviated by the lens to intersect axis at F'. The position of F' for a contact lens with given characteristics (refractive index n, center thickness t, radii of curvature r_1 and r_2) varies with h.

n, radius of curvature r_1) and the height of the incident ray (h). Each ray after traversing the substance of the contact lens (center thickness t), will be incident on the second surface (radius of curvature r_2) with a certain inclination and at a certain height. It will be deviated by the surface and will intersect the axis at a point F'. For parallel incident light in a given contact lens, the distance f_v' between the back vertex of the lens and the point F' will be a function of the incident height h.

When studying the influence of this contact lens on the eye, we may consider the emerging ray, directed to F', as incident immediately on the fluid lens which has an outside surface with the same radius of curvature as the inside surface of the contact lens. If the characteristics of the corneal surface in the zone involved are known, the ray traced thus far may be followed into the eye and its course compared with a similar one entering the cornea directly.

If the problem is confined to the specification of the contact lens in air, as in the verification of a prescription, the course of the rays is just as indicated in Figure 2. Instruments such as the vertex refractionometer are designed to simulate the passage of rays through a lens shown in Figure 2. The lens is placed against a stop which limits the passage of rays to a zone generally about 6 mm. in diameter ($h = 3$ mm. app.). This is a reasonable way of testing the lens since the stop is comparable to the entrance pupil of the eye which might readily be 6 mm. in diameter, or even larger. The reading obtained on the scale of a vertex refractionometer, the back vertex power, F_v', is the reciprocal of f_v', measured in air and expressed in meters (Figure 2).

The following table gives the computed values—obtained by simple ray tracing procedures—of F_v' for four representative contact lenses for three heights of incidence: a parallel paraxial beam, and rays parallel to the axis incident 1 mm. and 3 mm. from the axis, respectively.

Ideally constructed contact lenses with spherical surfaces may be expected to exhibit the indicated readings on a vertex refractionometer for a narrow paraxial bundle, and for thin annular bundles with diameter 2 mm. and 6 mm., respectively. When the whole 6 mm. aperture is exposed, the readings obtained may be expected to be weighted in the direction of the outer zone since these contribute proportionally more light to the image than the inner ones.

It should be pointed out that no *a priori* statements can be made concerning the retinal image quality in eyes that have been fitted with such contact lenses. As stated earlier, it is necessary to have good knowl-

POWER OF CONTACT LENSES IN AIR

	Lens	F'_v			$\Delta F'_v$	
		Axial Power	Away from axis 1mm	Away from axis 3mm	Away from axis 1mm	Away from axis 3mm
1.	r_1 = 9.4mm t = 0.1mm r_2 = 7.8mm n = 1.492	−10.44	−10.81	−12.49	−0.37	−2.05
2.	r_1 = 8.7mm t = 0.1mm r_2 = 7.8mm n = 1.492	−6.32	−6.43	−7.55	−0.11	−1.23
3.	r_1 = 7.4mm t = 0.5mm r_2 = 7.8mm n = 1.492	+4.31	+4.42	+5.28	+0.11	+0.97
4.	r_1 = 6.7mm t = 0.75mm r_2 = 7.8mm n = 1.492	+13.16	+13.57	+16.25	+0.41	+3.09

F'_v is the reciprocal of the distance, in air and expressed in meters, between the back vertex of the lens and the point at which an incident ray parallel to the axis intersects the axis in image space.

edge of the corneal contour of an eye before extending the ray tracing into the cornea. The Stiles-Crawford effect, which reduces the luminous effectiveness of rays entering the periphery of the pupil, must also be kept in consideration.

The findings are, however, directly applicable to the measurement and evaluation of contact lenses. It is clearly necessary to limit the aperture of vertex refractionometers if valid estimates are to be obtained of the back vertex power of a central area of a contact lens in air. Moreover, proper evaluation of the quality of a contact lens would seem to demand, as a pre-requisite, a knowledge of the expected optical performance of an ideally constructed lens. Table I shows what this is for some typical contact lenses with spherical surfaces.

SUMMARY

The relative significance of the various monochromatic aberrations are briefly discussed as they pertain to spectacle lens and contact lens corrections.

It is pointed out that spherical aberration is the most important aberration in contact lenses.

The spherical aberration of four representative contact lenses in air, computed by ray tracing procedures for parallel incident beams at various heights of incidence, are given.

The computations give the expected values of aberrations of ideally constructed spherical contact lenses as measured on the vertex refractionometer. A detailed knowledge of the corneal configuration is necessary before applying them to a contact lens correction on the eye.

SPECIAL REPORT

HOW THE SENSE OF SIGHT SERVES MANKIND*

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Let us see how man utilizes the sense of sight for his own practical use. At first we shall focus our attention on the more common occurrences, so that we may determine certain general facts and conditions. Towards the end of the article we shall consider questions pertaining to the application of these facts in the newest technical achievements.

1. There are many factors which indicate how the organs of sensation (especially the eyes) are dependent upon conditions of use. Data of these characteristic changes in various professions have been gathered in special laboratories. One of these investigations has been devoted to the recognition of color by smelters. The study was executed by collaborators of the National Institute for the Safety of Labor.

The necessity to give the molten metal a greater degree of fusion requires the maintenance of maximum temperatures of open-hearth furnaces. But the temperature of the molten metal has a definite limit. For this reason, the smelter watches the bright incandescence on the top of the furnace through blue glasses. In the region of critical temperatures he sees a pale blue light on the top of the furnace; by extremely small changes of this color the smelter can judge and regulate the temperature. Thus, the ability to recognize definite colors serves the smelter with means to judge the temperature of the molten metal. Little by little, professional experience teaches him to note extremely fine variations in the pale blue color which cannot be detected by men of other professions. The processes of improving recognition of the colors can be accelerated if those who are learning to be smelters go through a period of special training.

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The conditions governing the sense of sight, especially during the early years, have essential significance for the formation of certain of its functions, as for example, acuity of vision. The significance of illumination as a causative factor in the development of near-sightedness can be seen from the following data of schools situated on wide streets—2 to 8%; while in schools situated on narrow streets, with densely congested buildings—8 to 15%; in schools where the ratio of window area to the area of the floor was 15%, near-sightedness occurred in 8%; in schools where this ratio was greater, namely 20%, near-sightedness occurred in 6.5%.

The influence of the level of lighting on the acuity of vision is clearly seen in the comparison of the number of near-sighted students before and after the installation of electric illumination. When the illumination was with kerosene (which produced 2 to 3 lux) near-sightedness in schools was 33%. The installation of rational illumination and other hygienic light producing agents reduced the number of near-sighted pupils. [The percentage of reduction is not given. —I. D.]

These measures received special expanse in Russia after the October Social Revolution, when new brightly lit schools were built, practically all of them electrically illuminated. And if there were 10 to 20% near-sighted pupils prior to the revolution, the number of them decreased several-fold after the revolution.

The percentage of myopes is greater among intellectual workers and professions which require exact and fine visual discrimination (typesetters, engravers, seamstresses, etc.) and work that is linked with reading or the observation of small objects at close range. The greatest effect on the preservation of sharpness of acuity is illumination. During the past century, when electric illumination was not yet available, there were 40% myopes among typesetters, while at present there are only 15%.

The facts enumerated above indicate the importance of planned active measures to improve the function of the organ of sight.

In our times, certain bourgeois scientists claimed that at the moment of conception, when the ovum joins with the sperm, the question of sharpness of acuity of the future individual is settled. This opinion effectively throttled prophylactic measures in the domain of eye hygiene of school children. Actually, one may inherit certain tendencies for definite acuity of vision, but external factors can either develop or restrain these tendencies.

Man's utilization of his organ of sight can be broadened as can

be seen from a study of the other senses. The food industry with its enormous diversity of products enriched and developed man's sense of taste. Workers in the food industry, food hygienists and sanitary workers (particularly, tasters) invariably improve their sense of taste in the performance of their specialty.

In the transportation professions (chauffeur, bus driver, etc.) and in the closely related profession of the aviator, dynamic visual development plays a special role. The dynamic visual judgment depends on the rapidity of the "influx" of objects, their form and dimensions, distance to the objects and familiar signs (all clearly discerned as the objects are approached) during the interval of time between awareness and subsequent action.

In the work of the aviator, linked with the necessity to "feel" the plane and its complex evolutions in space, changes in speed, etc., and the integration of sensations from all sense organs is of great significance. The sensation of pressure on the steering wheel and upon landing, in combination with visual and auditory sensations, help the aviator to solve his important problems.

In the process of man's activity, there are a number of conditioned reflexes resulting from participation of the hearing sense. For example, we can determine from the sound the direction of an approaching automobile and we react to this with lightning-like rapidity. Of great significance are similar conditioned reflexes linked with many professions (workers in machine plants, transport, hunters, etc.).

The development of fine auditory perception from the influence of occupational activity is observed in many professions, but especially clear examples can be found in the work of judging the quality of crockery, which gives off its own characteristic sounds, when tapped lightly.

Another example—musicians have a fine sense of hearing, but in violinists it is more developed than in pianists: since players of string instruments must exercise their sense of hearing to a greater extent.

Finely developed tactile and kinaesthetic perception is observed among millers. A miller can discern by touch the quality of the grist and the type of wheat from which the flour was prepared.

We have seen that in the process of work man can learn to make greater use of his sense organs, attaining greater productivity and quality of work. The awareness and intensification of the worker and his interest in mastering of fine skills plays a major role in this. Many seemingly unapparent things, or those which are only vaguely perceived, become objects of intense attention on the part of the worker, if he is

really interested in attaining a greater and higher index of productivity.

2. Up to this time we made use of material from the work of man in conditions of daily activity. We shall now examine the results of several special experiments related to our original theme.

Of great practical significance is the development of acuity of vision, as a result of exercises, in those who have had a reduction of vision. In strabismus one eye does not function in the act of seeing, with the result that the acuity in the crossed eye is reduced without a noticeable change in the transparency of the media or in the fundus of the eye. In these cases, the better seeing eye is occluded for a period of time; the patient is then obliged to use the eye with the poorer vision. After a period of training, the eye with the poor vision begins to see better and after a while the visual acuity is noticeably improved. The increase of vision in the poorer seeing eye can bring about an increase of vision in both eyes and elimination of the strabismus. The above described method of treating strabismus in children has been only recently applied. At present, visual exercises are combined with an operation on the eye. Special exercises to improve visual acuity have been used in Russia by A. Geno and V. Dobrovolsky as far back as the last century. As a result of these exercises, the fields of vision in the horizontal meridian enlarged, in the experimental cases, templeward from 45 degrees to 80 degrees and nasalward from 38 to 55 degrees.

Training can produce greater noticeable results in complex situations involving the recognition of aircraft. An experiment was conducted on the effect of training in the recognition of shapes of aircraft as seen through a small visual angle. To conduct the experiment, models of airplanes of various construction were used. It was proven that training can significantly improve recognition. One of the subjects in the experiment identified a model plane the first day at a distance of 6 meters—on the fourth day—at 13 meters. On the seventh day the subject identified a plane at a distance of 22 meters and maintained the recognition at this distance to the eighth and ninth day. As a consequence of the training, the recognition of shapes of aircraft was improved four-fold.

L. E. Seletskia studied the influence of practice to improve the smelter's ability to distinguish the temperature of the furnace by color. One group of subjects practiced on an apparatus which constantly gave them the opportunity to note their mistakes and which also indicated "how accurate it should be." The other group studied in the work-shop where the instructions on "how to be accurate" was limited and there was no chance to change the temperature of the furnace dur-

ing the process of pouring the ingredients, once it had begun. After the training, both groups improved significantly in their accurate judging of the furnace temperature in the work-shop. However, those subjects who were trained on the apparatus were better able to judge the temperature than those who received instructions in the work-shop. According to the data, those who practiced on the apparatus improved almost five-fold in their ability to judge the exact temperature.

Exercises can also be said to improve organs of sensation in ordinary circumstances—discrimination of brightness and discrimination of sounds of high pitch. Seletskia trained 22 student textile-colorists in the discrimination of brightness between two adjacent color fields. The subjects were divided into two groups, one of the groups exercised in the discrimination of brightness of the red color, and the second group on discrimination of the green color. Controlled experiments were conducted on both groups with the blue color and, in addition to this, on the "green" group with red color and on the "red" group with green. In this manner, it was possible to obtain information about the influence of training in discrimination of brightness differences of one color as a means of helping to discriminate brightness differences of other colors. In the training experiments, the instructor corrected the subjects' errors and showed them the true brightness equality.

As a result of six training sessions, the errors among the "green" and "red" groups decreased approximately two-fold. The greatest rate of improvement was noted during the first days of practice and the training effect lasted for a significant period of time, long after the training had been discontinued.

Seletskia informed us that carrying out the training routine in disctimination of brightness gave a definite productive effect. Upon the completion of the task of practical coloring (it was required of them to color material by copying from samples), the students who had received special training expended less time to finish the task than students who did not receive the training.

The functions of the organs of sensation were also investigated with exercises under conditions of every day usage. It is interesting to call attention to the role that these exercises play on the organs of sensation, which ordinarily, in our every day of life, do not take part or only rarely participate: for example, side vision. The study of exercises in the discrimination of colors and forms with the periphery of the retina showed that the field of color vision and the discrimination of forms (circle, cross, triangle) widens from one experiment to another. Therefore, there exists the possibility of widening the fields

of vision for the perception of colors and the discrimination of forms. In those instances where the subject under training undertook to see as far as possible, he set before himself a row of symbols by which he could determine their color and form.

3. The number of experiments which disclosed the role of exercise in the various functions of the sense organs, and the frequent finding of the use of the organ of vision, requires that the subject matter be investigated on another plane—that is, the position of higher nervous activity. The fact of the matter is, where there were certain improved results following a series of exercises, it was demonstrated that improvement was possible even at the very start. It was sufficient merely to change appropriately the manner of instructions given to the subject for him to immediately make the maximum use of his sense organs, without special exercises.

For example, the results obtained by experiments conducted by L. A. Schwartz. In the first series of experiments the symbols used were of the customary size; therefore, the subject did not have to display his maximum acuity of vision. In a second group of experiments the subject observed an image of a black ring with a white opening. According to the position of the white opening in the ring, the subject was required to press various telegraph keys attached to an electro-magnetic circuit. The set-up was so constructed that by pressing the wrong key, a ball attached to the circuit became disconnected and fell. The task before the subject of the experiment consisted of preventing the fall of the ball, i.e., to exert the maximum visual acuity. In this manner, the determination of the position of the ring was not the main goal, but a means to successful accomplishment of another test. Maximum acuity of vision was achieved as a result of the use of the ring with gradual diminution of the opening in the ring.

Experiments conducted on eight adults demonstrated a sharp increase of acuity of vision at the very beginning. Thus, if the original acuity during the first series of experiments is assumed to have been 100, when measured in the customary manner, then the mean increase of acuity attained in the first experiment of the second series was 160, and during the third and fourth experiments—it was 200. We have to assume that in most instances the subjects made use not only of signs based on previous visual acuity, but that they also learned to take into consideration new and more difficult signs to discriminate.

The results of the second series of experiments seem to indicate that exercises have an influence on the acuity of vision. This is not true. Actually, the experiment in discrimination indicated that the

maximum acuity, obtained in the second series, can be gained immediately without special exercises, if the subjects are given instructions which would make it possible for them to utilize to the maximum their visual ability. In other words, the results of the experiments can be said to depend on the character of the instruction given the subject, rather than on the exercise or function of the visual organ. It all comes within the domain of higher neurological function. Unfortunately, many published investigations of the function and exercise of the sense organs, in particular the organ of sight, have not as yet been evaluated from the position of higher neurological function. As for example, the explanation of the influence of the character of instruction on the results of experiments as given above.

4. What new effects will the scientific and technical advances have on the organ of sight?

In aviation and in many other branches of technology the nature of the work produces a special strain on the eyes. If we are to judge from the recent publications, present day airplanes attain a speed of five times that of the speed of sound and achieve a speed of 6000 kilometers an hour. The pilot experiences a blackout of perception and reaction which lasts nearly a second. Therefore, for the speed of flight, at three times the speed of sound, an object perceived by the pilot at a distance of 100 meters, in reality is abreast with the plane. In other words, two pilots flying in opposite directions to each other, will not see each other, if one of them appears from a cloud at a distance of less than 200 meters. The planes would collide, since the pilots would not have sufficient time to change their course. The reaction time would be increased if the plane appeared on the periphery of the visual field, for it would be seen more quickly.

Because of the flight at speeds greater than that of sound, every seeming alteration of objects appears as the effect of the flow and condensation of air molecules on the nose of the plane, directly in line with the pilot's view. At these speeds, every sudden and apparent increased size of objects is beyond the range of true evaluation of heights and other determinations. At speeds nearly equal to that of sound, the vibrations of the plane, if they total from 20 to 90 oscillations per second, can seriously affect the function of vision. All of these circumstances lead to the effort to replace the pilot's work and the function of his vision with radar, automatic piloting devices and electric calculating machines which are indispensable for the navigation of the flying apparatus.

In the cabin of a plane navigated by a pilot, an effort is made to

arrive at more or less concordance between technology and man's visual function: since an error in computation of the instruments' indicators can lead to destruction.

In foreign literature there frequently appears work devoted to vision by radar, vision in connection with the instrument panel arranged before the pilot, and to the application of optically corrective measures on pilot's eyes. We shall stop here and discuss them.

In the elements forming the basis of radar lies uninterrupted reception of reflected ultra-short radio waves from outer objects. The reflected waves are detected by the antenna of the plane and, after suitable adaptation, find themselves in the electro-illuminated tube. The walls of the tube, facing the observer, are covered with a luminous paste and serve as a screen for observation. On the screen of the radar are received the images corresponding to the objects: those having greater reflecting quality are received clearer than those having lesser reflecting characteristics. The radar screen does not furnish ideal reflection of all subjects, making it difficult sometimes to detect and identify. In this case, the organ of vision and the entire nervous system connected with it functions under strained conditions. Therefore, a satisfactory working relationship between the technical possibilities of the instrument and the organ of vision in particular is definitely necessary.

By means of radar orientation on the border of the plane, the technical and physiological factors are directed first of all on a line that is best suited for the interpretation of the images projected on the radar screen. The curved view of the radar screen presents a constantly changing picture of contrasting relationship of figure and ground, as well as the spectral glow emitted by the luminous paste. The discrimination of objects on the radar screen depends on the contrasting sensitivity of the visual analyzer and on his ability to differentiate forms. In the construction of radar the aim is to both improve the characteristics of the images and to decrease the impediments which depend on the peculiarity of the electric apparatus and the screen. From this point of view one must take into account the various facets of the physiology of sight and the peculiarity of the instrument. Nevertheless, specialists are of the opinion that in spite of improvements in the reception of the images and in their decoding, the optimum coordination between vision and technology has not yet been attained. The instrument panel in front of the pilot is of first significance. The technical and visual coordinations are concerned here with the construction and design of the dial of each instrument, number and distribution of the instruments on the instrument panel, as well as its illumination, etc.

Among the different requirements demanded of aviation instruments, foremost in importance is the speed of flight and accuracy of calculations. For the execution of these requirements, the eye acting as a receptor of information is of exceptional significance, because of its ability for rapid and quantity determinations. In order that the data of the instrument be faithfully recorded, its scale must confirm to the psycho-physiological peculiarities of vision. The dimensions of the letters and the figures must be at a suitable distance from the eyes, and the marks on the dial must be of a suitable form, affording the optimum contrast between the instrument and the background, as well as between the dial, its figures and indicators. The brightness of the central and peripheral parts of the instrument must meet the requirements of being easily seen in daylight and in darkness.

In the past, the number of instruments with their symbols was sufficient to provide favorable conditions for the functioning of the eyes. In those days it was easy to provide instruments of large dimensions, because there was ample room on the instrument panel. At present the panel is filled with instruments and its rational organization presents an important problem of coordinating the possibilities of technology with that of vision. An effort is made to combine aviation instruments in groups according to their use (for example, navigational instruments); important and frequently used instruments are placed in the central field of vision; the attempt is made to decrease the number of instruments from a score or two to 6 and 8 pieces; to change the form of the panel and other ideas.

At first glance, it would seem that focusing of attention on minor details would be unimportant. However, appropriate distribution of mere cipher marks controlling the instruments makes any deviation from the normal more apparent. It was shown experimentally that correct placement of the ciphers reduced the number of errors two-fold.

The correct illumination of the instrument panel increases the visibility of the indicators on the instruments; does not tire the eyes and does not disturb their adaptability to darkness; eliminates the possibility of blinding the flier; and for a military plane, the possibility of disclosure. The full possibilities of optimum illumination of the instrument panel have as yet not been solved.

Aircraft builders are striving to reduce the bulk of visually working parts of the vehicle. To decrease the burden on the organ of vision, in critical moments of flight or during fatigue, an attempt was made to change the visual signals to sound signals and in some instances to employ pressure and contact as an aid to the pilot's attention. The

greatest results thus far attained have been from switching parts of the visual information to that of the organ of hearing.

Optical instruments for the correction of the optical system of the eyes are constantly being introduced in aviation. We are referring to the use of periscopes and binoculars by the pilot as well as the introduction of contact lenses in place of spectacles. Many experiments are now being conducted on the use of periscopes in flight and landing. The situation with the construction of periscopes gives a basis of hope for the removal of the large cabin searchlights to improve visibility on present day planes. The flier will be required to pilot a plane from a prone position. Because of similar changes in the construction of the cabin, there are improvements in the aero-dynamic quality of the plane, and the safety of the crew is increased and protection from ultra-violet rays is achieved.

The change from spectacles to contact lenses is taking root more and more in the practice of different professions. In cases where the use of contact lenses are professionally indispensable (pilots, for example) 80% of them get accustomed to wear the contact lenses within a few hours. It is noticeable that when contact lenses are not worn for professional purposes this percentage is lowered to 30%.

Flights in cosmic space and flights at high altitudes present completely new questions of the capability of human vision. How then do the eyes function in cosmic space?

At the limit of the atmosphere the cosmic vehicle ceases to be an airplane in the usual sense of the word: after the flying body leaves the medium of air, the projection of its movements is possible only with the help of rocket propulsion. After a short period of acceleration at the moment of start, the acceleration begins to fall off, until it reaches the zero level.

Beyond the limits of the atmosphere the cosmic crew finds itself in a state of "weightlessness." The gravitational force appears again only upon the approach to another heavenly body and upon return to earth. Of course, there are means to escape the condition of weightlessness on the cosmic ship. It is possible to convey uninterrupted acceleration. But for the present this is out of the question, in view of the complex problems of the type of combustible material to use for propulsion. The conservation of fuel is another characteristic problem of cosmic flight. There are proposals to substitute earth's gravity with the force of inertia, for the passengers of the ship, if uninterrupted movements are to be achieved. It is assumed that men can get used to the changes from the earth's gravity. But all this requires completely

integrated psycho-physiological research, particularly with reference to the organ of vision, functioning in these unusual situations.

Although it is possible to escape weightlessness in flight beyond the earth's atmosphere, in the initial stage of cosmic flight the passengers of the vehicle will be in a state of weightlessness. This gives rise to a completely new problem of man's orientation of his position and movements in the absence of gravity. If in the presence of gravity, "down" is where the force of gravity is, then in a state of weightlessness it can be assumed that "down" will be where the feet are turned to. Therefore, in a state of weightlessness, orientation within the space of the cabin will be in a situation where "up" and "down," as a rule, will not exist for the members of the crew and the role of orientation within the space of the ship will be assumed by the organ concerned with visual analysis. We shall examine a few theoretical premises that lead to such a conclusion.

During the time when the force of gravity is in effect, man is able to orient himself with his surroundings by means of three mechanisms of analysis: the vestibular apparatus controlling his equilibrium in space; the proprioceptive apparatus providing for muscular sensation, and the organ of sight. In ordinary situations, when man is "earth-bound," his visual sense informs him with respect to a given height; however, this function does not play the principal role, since man can orient himself in space without the sense of sight. It becomes the paramount factor only when one or the other of the two functions becomes defective. For example, without proprioceptive sensation, as may occur in tabes dorsalis, man loses his equilibrium upon closing his eyes.

In a situation of weightlessness, the sense of sight has to contradict the signs of the receptors which usually characterize our position when gravity is in force. In weightlessness the equilibrium apparatus located in the middle ear is affected the most and, as a result, fails to send the customary signals to the brain centers. It would be expected that muscular coordination, provided by the proprioceptive apparatus, would also disappear and the aiming of hands and feet would acquire a different character than in the field of the earth's gravity.

Even five years ago, as a result of similar considerations, when there was not as yet available experimental data relating to orientation in situations of weightlessness, it was suggested, as an hypothesis, that visual analysis will be the prime factor in orientation in space in a situation of weightlessness. The basis for this reasoning was that the organ of sight need not substantially alter its function and therefore

can be of great help to the passengers of the ship in orienting themselves within the cabin.

Experiments conducted during the past few years have confirmed in principle the indicated theoretical expectations, and at the same time have correctly substantiated our knowledge of the functions of the sense organs regarding orientation in space during weightlessness. The influence of weightlessness on man's sense organs is known: of course, not sufficiently enough, since suitable experiments have been only recently started. In the published data of 1957, the influence of weightlessness was observed for only 40 seconds during the actual flight of a plane and for three minutes during the flight of a rocket. To reach weightlessness, the plane rotated on a parabolic curve with the motors operating to overcome air resistance. During the rotations of the plane, weightlessness lasted about 30 seconds and sixteen men participated in the experiment. Eight of the men expressed themselves as feeling "pleasant" during the weightlessness: the feeling of falling wore off shortly after the start.

The functioning of the sense of sight was not diminished in the sixteen men while they experienced the sensa ion of weightlessness, which leads to the conclusion that cosmic travelers will be able to orient themselves to their surroundings by means of their sense of vision. As for the coordination of movements in a state of weightlessness, according to one investigation, the fliers experienced a definite disturbance in the coordination of their movements and a hinderance in their ability to control the plane. As a result, several fliers became giddy, lost spatial orientation and ceased to exchange caustic remarks with each other. It is important to note that training made possible a decrease in the marked negative phenomena. Another investigation disclosed that, after being in a weightless situation from 15 to 20 seconds while flying over an appropriate trajectory, no significant disturbances in orientation and muscular coordination were noted.

In 1954 there was published in foreign literature the results of a number of experiments on the examination of visual orientation and muscular coordination during the absence of the force of gravity. In these investigations, the men were in a state of weightlessness and were required to mark crosses within seven small squares distributed diagonally on a large square whose sides measured 21 cm. The sheet was fastened to the instrument panel. The experiments were conducted with the subjects having their eyes open and closed. In the experiment with open eyes, although it was difficult to draw the crosses on

the diagonal, they were relatively even and the quality of the work improved with training. In the experiments with closed eyes, the drawing of the crosses deflected from the diagonal. The experiments made apparent the role of sight for the correct coordination of moments during the period of weightlessness. On the basis of limited experimental material, it is believed that the correct information received by man through the organ of sight, regarding his surroundings within a cabin of a cosmic ship, maintains his equilibrium and the ability to orient and to move about in the event of a lengthy period of weightlessness.

What kind of influence does high altitude flying have on the organ of sight?

During high altitude flights—man has already reached almost 40 kilometers—the closing of the eyelids for the protection of the flier's eyes from the action of radiant energy becomes difficult. On high altitude flights, the ultra-violet and infra-red rays of the sun are intensified to such a degree that they can cause injury to the eye similar to that of snowblindness as well as retinal burns. The protection of the eyes from these radiations are accomplished with the help of special lenses which absorb "dangerous" portions of the spectrum: but at present, it is still difficult to construct a lens suitable for the infra-red or heat rays.

The illumination of the instrument panel, during high altitude flying, needs special consideration. At the height of 30 km. the brightness of the sky is reduced thirty times as much as it is at 3 km., and at 100 km. the sky appears almost black. In addition, at high altitudes there is an increase in the brightness of the lower layers of the atmosphere which contain evaporation and dust; this brightness increases with layers of clouds below. At high altitudes this bright light blinds the flier's eyes. The rays of light entering the cabin are for the most part direct rays of the sun and very little dispersed light. There is a great contrast in the cabin between the illuminated and the non-illuminated objects. Consequently, there is difficulty to differentiate the indicators on the instruments, unless the rays of the sun do not directly illuminate the instrument panel. This is the reason for the great contrast between the different instruments and in any given instrument between the markings, pointers and background. In these instances, the reading is made possible only with special lighting installed within the cabin.

At high altitudes of 30 to 40 km., ionization of the cosmic rays amounts to nearly 1 roentgen in 24 hours. Thus, if a high altitude

flier is permitted to remain aloft even only 24 hours in a week, he will receive 1 roentgen in a week: this amounts to almost one-third of the permissible dose for man. These calculations indicate the existence of immediate danger from cosmic rays for the flier in the region of 30 to 40 km. and lower. It is possible, from some of the changes produced by the cosmic rays at these altitudes, that there may be a more powerful specific effect than has been figured, because the calculations were estimated from the beta and gamma rays, excluding alpha particle radiation.

In the case of the eyes, changes produced by cosmic rays, can be anticipated to produce undesirable effects, if we take into account the sensitivity of the retina to ionization and the equally easily formed cataract. This problem requires further study. It is appropriate here to remind ourselves of the probable injurious effect on the eye from receiving doses of ionization through radiation, although the danger from small doses of ionization has not been proven. It is known that man senses a flash of light when X-rays which are projected toward him are turned on and off. In our experiment jointly with E. O. Boordiansky this reaction could be observed with very small doses of radiation—in the order of 0.001 roentgens—on a section of the eyeball. Nevertheless, similar doses are obviously not dangerous, for even under normal conditions the daily permitted radiation is 0.05 roentgens.

The development of cybernetics during the past few years has given rise to hope of help from this science for the study of functions of the centers of analysis, in particular, with reference to the question of man's use of his visual centers. Actually, the transmission of information by the centers of analysis within the brain (and from the peripheries) of outer surroundings, give a basis for the application of research with cybernetics. There have already appeared works from this point of view dedicated to the study of man's and animal's visual centers of analysis. It is to be hoped that in the not too distant future this branch of study will produce more significant results.

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BIBLIOGRAPHY*

1. Andrayev, L. M.: Physiologia Organov Chuvstv. Izd-vo MGU, 1941.

*Bibliographies in the JOURNAL are customarily edited by the bibliographic editor. Since the present bibliography accompanies a translation, it has not been altered in editing. The translator, Dr. Dvorine, has rewritten the titles in our alphabet. Other than this, the bibliography is reprinted exactly as it appeared in the original paper.

2. Bongard. M. M.. i Smirnov. M. C.: Chetirekhmernost Tsvetovogo Prostranstva Cheloveka. Dokl. AN CCCR. 1956. t. 108. No. 3. str. 447.
3. Bizov. A. L., Utina. I. A.: Dvizhenie Palochek Setchatki Liagooshki i Mesto Vozniknovenia Electroretinogrami. "Biophisika." t. 4. v. 2. 1959. str. 187.
4. Vavilov. S. I.: Glaz i Solntse. Izd. 5. Isd-vo AN CCCR. 1950.
5. Walls. G. L.: The Vertebrate Eye and Its Adaptive Radiation. Bloomfield Hills 1942.
6. Vishnevsky. N. A.: O Biologicheskom Deystvii Ionizirooushtey Radiatsii na Organ Zrenia. "Vestnik Ophthalmologii." 1958. No. 5 i 6.
7. Voodvorts. R.: Experimentalnia Psichologia. M. IL. 1950.
8. Geratevol. Z.: Psichologia Cheloveka v Samolete. M. IL. 1956.
9. Granit. R.: Electrophisiologicheskoe Issledovanie Retseptsii. M. IL. 1957.
10. Greenshtein. A. M.: Pooti i Tsentri Nervnoy Sistemi. Izd. 2. M.. 1946.
11. Goortovoy. G. K.: O Materialisticheskom Ponimanii Prorodi Organov Chustv. V sb.: "Philosophskie Voprosi Sovremenoy Biologii." Izd-vo AN CCCR. 1951.
12. Goortovoy. G. K.. Goorevich. L. V.. Moorzaeva. L. B.. Seletskaia. L. I.. Iampolskaia. T. G.: Issledovanie Zakonomernostey Tsvetovo i Prostranstvenogo Zrenia i ich Ispolzovanie dlia Povishenia Effectivnosti Dorozhno-Signalnich Znakov. "Troodi Instituta Biologicheskoy Phisikia" t. I. Izd-vo AN CCCT. 1955.
13. Kott. Kh.: Prisposobitelnaia Okraska Zhivotnich. M. IL. 1950.
14. Kravkov. S. V.: Glaz i evo Rabota. Izd. 4 Izd-vo AN CCCR. 1950.
15. Kravkov. S. V.: Tsvetovoe Zrenie. Izd-vo AN CCCR. 1951.
16. Lazarev. P. P.: Sovremennie Problemi Biophisiki. Izd-vo AN CCCR. 1945.
17. Lieberman. E. A.: O Kharactere Informatsii Postoopaushtey v Mozg. "Biophisika." t. 2. v. 4. 1957. str. 427.
18. Pavlov. I. P.: Dvadtsatiletni Opit Obektivnovo Izoochenia Vishey Nervnoy Diatelnosti (Povedenia) Zhivotnich. Izd. 6. Gos. Izd-vo Biologicheskoy i Meditsinskoy Literatoori. 1938.
19. Polyak. S.: The Retina. Chicago. 1941.
20. Preobrazhensky. V. V.: Loochevaia Terapia Glaznich Bolezni. "Vestnik Ophthalmologii." 1958. No. 4. str. 45.
21. Preobrazhensky. V. V.. Roslavtsev. A. V.: XVIII Mezhdoonarodni Congress Ophthalmologii. "Vestnik Ophthalmologii." 1959. No. 1. str. 38-59.
22. Semenovskaia. E. N.: Raboti po Voprosam Foonktsionalnoy Labilnosti Zritelnovo Analizatora. V sb.: "Problemi Phisiologicheskoy Optiki." t. 7 (1949). t. 9 (1950) i t. 10 (1952).
23. Sepp. E. K.: Istoria Razvitia Nervnoy Sistemi. Medgiz. 1949.
24. Khartridzh. G.: Sovremennie Uspechi Phisiologii Zrenia. M. IL. 1952.
25. Shmalgaoozen. I. I.: Osnovi Sravnitelnoy Anatomii Pozvonochnich Zhivotnich. Izd. 4. Isd-vo "Sovetskaia Naooka." 1947.
26. Iarboos. A. L.: Vospriatie Nepodvizhnovo Setchatochnovo Izobrazhenia. "Biophisika." t. 1. vip. 5. 1956. str. 435.

ANNOUNCEMENT

MAZOW MOVES TO FLORIDA

Bernard Mazow, O.D., F.A.A.O., announces the opening of his office at 373 Alhambra Circle, Coral Gables, Florida, for the general practice of optometry, and for referrals and consultations in the fitting of Contact Lenses, Sub-Normal Vision Aids, Aniseikonia, and difficult refractive problems. Dr. Mazow formerly practiced in Houston, Texas.

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ACADEMY POST-GRADUATE COURSES AT CHICAGO

A review of the seventh annual Academy Post-Graduate Course series, scheduled for all optometrists at Chicago, December 6, 7, 8, 1961, at the Drake Hotel is submitted on the following pages. This exceptional arrangement of 83 courses, each offered by an outstanding specialist in his subject, is we believe the finest example of Post-Graduate education ever placed before the profession. These Academy Courses are presented under the supervision of Dr. V. J. Ellerbrock of the Ohio State University and his Committee. They have carefully screened their instructors who come from private practice and from our schools and colleges. The Committee is again presenting an array of talent entirely typical of Academy events. Every member of the profession is invited to take part. For most classes attendance is limited only by the size of the classrooms. Advance registration is suggested.

Now how about the attendance at these Post-Graduate Courses in Chicago? Naturally, we cannot be certain, but with six years of experi-

ence in arranging this sort of thing we can make some rather well founded guesses. We believe these courses will be well attended. In the past they always have been. In addition we believe that those optometrists who enroll will be enthusiastic over the quality of instruction they receive. These courses are carefully planned and reviewed. The instructors are the very best the profession has and they come prepared to do an exceptional job. These men are qualified specialists in their subjects.

All of this points to early advance registration. The advantages of getting your tickets now are that this assures you of a seat in each course of your choice. Where non-limited courses are packed, and they sometimes are, the holders of advance registration tickets are seated and the others who waited until they got to Chicago to get their tickets may have to stand around the edges of the classroom. While there is no harm in this (the instructor is also on his feet) it's lots nicer to sit through a class. Another advantage in securing your tickets through advance registration is that it avoids waiting in line to purchase tickets at the registration desk and in addition there is no extra cost for this special service.

For the courses with limited attendance an early purchase of an advance registration ticket is the only sure way of getting in the class.

The schedule of courses listed on page 467 shows that at 10:00 A.M. on Wednesday, December 6, courses #63, #20, #40, #68 and #12 will start. The schedule also shows the day and hour that other courses start during this three-day period. In the Key to Designation of Periods, page 468, W stands for Wednesday, T for Thursday and F for Friday. The number indicates the hour the class is to start.

Readers are requested to study the outlines of the 83 courses given on the following pages. Then plan your time and arrange each day's sequence and mail in your order and check for tickets at once. A form for this purpose will be found on page 479.

CAREL C. KOCH

AMERICAN ACADEMY OF OPTOMETRY

POST-GRADUATE COURSES

The Drake Hotel

Chicago, Illinois

December 6, 7, 8, 1961

GENERAL INFORMATION ON POST-GRADUATE COURSES

Time: All courses are scheduled for the three days immediately preceding the regular annual meeting of the Academy.

Place: All of the courses will be taught in the Drake Hotel.

Applicants: Any optometrist may apply for one or more courses. However, Academy Fellows have preference in advance registration for limited courses only, until September 21, 1961.

Cost: The cost per hour of instruction is $2.00 unless otherwise specified. Tickets for courses are sold on this basis.

Enrollment: Advance registration is advised for all courses and for those with limited attendance it is the only sure way to be assured of a seat in the class. For all courses, the limited number of advance registration tickets will be valid without question. Tickets for unlimited courses may also be purchased at any time during the courses at the registration desk. These are interchangeable between courses and may be used for any unlimited course, (or limited course providing there is space available), at the rate of one or more tickets per hour of instruction.

1 hour course—1 ticket
2 hour course—2 tickets
etc.

Without exception everyone must register and pick up the appropriate tickets before entering the class rooms. Without them no one will be admitted.

Deposit: The total fee for each course must accompany the application.

Number of Courses: Eighty-three (83).

Hours of Instruction: One hundred and sixty-nine (169).

Applications: All applications for courses must be sent to
American Academy of Optometry
1506-1508 Foshay Tower
Minneapolis 2, Minnesota

Checks: Make checks payable to American Academy of Optometry.

Lecture rooms: These will be posted at the registration desk. The hotel bulletin board will state the location of the registration desk. Please check your time schedule of courses. The Committee cannot be responsible for conflicts of scheduling.

Committee on Post-Graduate Courses:
V. J. ELLERBROCK, *Chairman*
R. E. BANNON
F. W. HEBBARD
M. H. KAUHL

SCHEDULE OF COURSES BY HOURS

Hour	Wednesday	Thursday	Friday
8:00 A. M.	36 45 56 8	21 24 27 38	59 74 48 52
9:00	36 45 56 8	22 24 14 61	57 42 48 39
10:00	63 20 40 68 12	63 20 10 29 12	63 6 35 3 50
11:00	63 20 40 68 12	63 20 10 29 12	63 7 34 3 50
12:00 Noon	5 11 53 64	77 23 54 16	80 41 13 3
1:00 P. M.	5 11 53 64	77 11 54 16	81 41 73 33
2:00	78 26 17 4 65	46 25 43 31 65	19 18 73 62 65
3:00	78 26 17 4 65	46 25 76 31 65	19 18 72 28 65
4:00	37 79 83 9	30 17 1 73	58 82 44 2
5:00	37 79 83 9	30 17 1 73	60 82 44 2
6:00			
7:00	55	51	
8:00	69 55 15 32 51	69 71 47 66 51	75 70 47 67 49
9:00	69 55 15 32 51	69 71 47 66 51	75 70 47 67 49

Course 1
Analysis of Problems of Retinoscopy
Merrill J. Allen, O.D., Ph.D.

Bloomington, Indiana

A two-hour course—$4.00

Periods: T-4, T-5

Retinoscopic reflexes for the normal spherical and astigmatic eye, with demonstration of procedures for neutralizing and interpreting the reflex. An especially designed projector will be used to demonstrate typical retinoscopic reflexes and their neutralization. Reflexes will be projected onto a screen and will include normal, astigmatic, scissors and keratoconic reflexes as well as those due to spherical and chromatic aberration.

Course 2
Efficiency and the Optometric Eye Examination
Merrill J. Allen, O.D., Ph.D.

Bloomington, Indiana

A two-hour course—$4.00

Periods: F-4, F-5

The objectives of an eye examination are screening for pathology, determination of refractive errors, and measurement of muscular imbalances as related to the patient's environment. Discussion will include methods of increasing the efficiency, speed, and accuracy of testing. Refractive and muscle balance tests will be covered, with related comments on illumination, communication, instrument and trial frame limitations, etc.

Course 3
Rapid Reading for Adults
Louis Anapolle, O.D.

Boston, Massachusetts

A three-hour course—$12.00

Periods: F-10, F-11, F-12

A practical course to improve reading ability and to conduct reading program for adults. The course will include demonstrations of tests, techniques, and training procedures to improve reading efficiency (perception training, speed reading, comprehension-retention and progress testing). Supplementary reading material will be provided for each registrant. Attendance limited.

Course 4
Home Visual Training
Louis Anapolle, O.D.

Boston, Massachusetts

A two-hour course—$4.00

Periods: W-2, W-3

Basic training procedures to aid the busy practitioner in solving certain difficult cases. Prescription of self administered training techniques for heterophoria cases, accommodation-convergence problems, anisometropia, pseudo myopia and early presbyopia.

Course 5
The Optics of Contact Lenses
Robert S. Arner, O.D.

Rockford, Illinois

A two-hour course—$4.00

Periods: W-12, W-1

An explanation of clinical problems by applying simplified geometrical optics to contact lenses. Stress will be given to true power of a lens, errors of measurement, residual cylinder, and lacrimal cylinder in toric contact lenses.

Course 6
Contact Lens Symptomotology
William R. Baldwin, O.D.

Bloomington, Indiana

A one-hour course—$2.00

Period: F-10

The significance of various symptoms in the

KEY TO DESIGNATION OF PERIODS

Time	Wednesday	Thursday	Friday
8:00 A. M.	W-8	T-8	F-8
9:00	W-9	T-9	F-9
10:00	W-10	T-10	F-10
11:00	W-11	T-11	F-11
12:00	W-12	T-12	F-12
1:00 P. M.	W-1	T-1	F-1
2:00	W-2	T-2	F-2
3:00	W-3	T-3	F-3
4:00	W-4	T-4	F-4
5:00	W-5	T-5	F-5
6:00	W-6	T-6	F-6
7:00	W-7	T-7	F-7
8:00	W-E	T-E	F-E

Note: In program of Courses. (E) denotes 8:00 P. M. Evening Course.

fitting of contact lenses will be discussed and evaluated. Methods for their alleviation also will be presented.

Course 7
Headaches — Mechanisms and Syndromes
William R. Baldwin, O.D.
Bloomington, Indiana
A one-hour course—$2.00
Period: F-11

The practical significance of headaches in the refractive examination.

Course 8
Accounting and Office Procedure
Otto J. Bebber, O.D.
Denver, Colorado
A two-hour course—$4.00
Periods: W-8, W-9

Modern office accounting and credit methods for the professional office. Methods of evaluating services, costs, and tax benefits.

Course 9
Reading Readiness
Lois B. Bing, O.D.
Shaker Heights, Ohio
A two-hour course—$4.00
Periods: W-4, W-5

Vision as it relates to reading: pre-school readiness for reading. Testing for factors related to visual success in both normal and brain-damaged children.

Course 10
Reading Disability
Lois B. Bing, O.D.
Shaker Heights, Ohio
A two-hour course—$4.00
Periods: T-10, T-11

Corrective measures and pertinent research. Interprofessional aspects, including reports to schools.

Course 11
Impression Fitting of Contact Lenses
Solon M. Braff, O.D.
El Monte, California
A three-hour course—$6.00
Periods: W-12, W-1, T-1

Eye impressions and the fitting of haptic lenses. Review of need based upon failures with corneal lenses: demonstration and clinical application of molding techniques, trial methods, lens construction, and adjustment techniques.

Course 12
Streak Retinoscopy
J. C. Copeland, O.D.
Chicago, Illinois
A four-hour course—$8.00
Periods: W-10, W-11, T-10, T-11

This course is intended for those who wish to improve their skills in objective testing. Many innovations in teaching the Streak Technique will make the course of special interest to both those who now use the Streak Retinoscope and those who desire to begin its use. Each student will be provided with the necessary equipment including a retinoscope, schematic eye, transformer and lenses. The course is conducted so as to give each man personal supervision and instruction as well as lectures for the group. Attendance limited.

Course 13
Aspheric Lenses—Design and Use
John K. Davis
Southbridge, Massachusetts
A one-hour course—$2.00
(By Invitation)
Period: F-12

The aberrations of strong plus lenses. Possible corrections and compromises. What the doctor and patient may expect.

Course 14
Accounts Receivable Control
Ramie B. Dick, O.D.
Sandusky, Ohio
A one-hour course—$2.00
Period: T-9

With increasing demands for credit it is imperative the optometrist maintain accurate records of his accounts receivable. Various systems are available and will be reviewed. Special emphasis will be placed on the *Todd-Hadley-Write-It-Once-System* which was designed especially for doctors. It provides positive daily accounts receivable control and is well adapted to optometric practice.

Course 15
Practice Management
Ramie B. Dick, O.D.
Sandusky, Ohio
A two-hour course—$4.00
Periods: W-E

Records for a recall system, and other office procedures, will be discussed and statistics on the relative values of mailing and telephone recall systems presented. The effective use of assistants, modern office techniques, intercoms, postage meters, dictaphones, and electric typewriters and similar aids will be reviewed. The public relations value as well as their efficiency will be evaluated.

Course 16
Ophthalmic Dispensing and Mechanics
Robert S. Eakin, O.D.
Los Angeles, California
A two-hour course—$4.00
Periods: T-12, T-1

Frame selection for anatomical and mechanical fit. Lens considerations. Principles, techniques, and innovations involved in adjusting frames and lenses to achieve accurate positioning and comfort.

Course 17
Sub-normal Vision and Clinic
William Feinbloom, O.D., Ph.D.
New York, New York
Edward Williams, O.D.
Denver, Colorado
Richard L. Hopping, O.D.
Dayton, Ohio
A four-hour course—$8.00
Periods: W-2, W-3, T-4, T-5

A combined lecture and clinic course designed to present and analyze problems of the partially blind patient. The applications of visual aids in caring for these patients will be covered in detail.

Course 18
The Physiological Optics of the Partially Blind Eye
William Feinbloom, O.D., Ph.D.
New York, New York
A two-hour course—$4.00
Periods: F-2, F-3

The effect of pathology and abnormalities on the physiological optics of the normal eye. The material presented in this course will enable the practitioner to screen, understand, and aid his partially blind patients.

Course 19
Visual Manifestations of Brain Tumors and Lesions
Ernest J. Giglio, O.D.
Bernardsville, New Jersey
A two-hour course—$4.00
Periods: F-2, F-3

Recognition of brain tumors and lesions, making use of optometric tests, stressing history taking and symptomology with recommendations for referral.

Course 20
Advanced Course on Corneal Lenses
Robert Graham, O.D.
Pasadena, California
and Associates
A four-hour course—$8.00
Periods: W-10, W-11, T-10, T-11

Techniques for success in fitting modern corneal lenses: methods for securing optimum results in regular cases as well as procedures employed in handling the more difficult problems. The course is for those who already have substantial experience in the fitting of corneal contact lenses.

Course 21
Optometric Writing
James R. Gregg, O.D.
Los Angeles, California
John G. Sugg, O.D.
Fayetteville, Arkansas
A one-hour course—$2.00
Period: T-8

How to put a message across most effectively in writing for the general public and popular magazines.

Course 22
Effective Public Relations for an Optometric Office
James R. Gregg, O.D.
Los Angeles, California
John G. Sugg, O.D.

Fayetteville, Arkansas

A one-hour course—$2.00

Period: T-9

A round-up of ideas to build public relations, especially in the office: the use of bulletin boards, pamphlets, etc.

Course 23
Optometric Public Speaking
James R. Gregg, O.D.
Los Angeles, California
John G. Sugg, O.D.
Fayetteville, Arkansas

A one-hour course—$2.00

Period: T-12

Suggestions for effective public speaking to lay groups, such as service and civic clubs, PTA, etc.

Course 24
Early Detection of Ocular Pathology
Theodore Grosvenor, O.D., Ph.D.
Houston, Texas

A two-hour course—$4.00

Periods: T-8, T-9

A presentation of the subjective symptoms and clinical findings which can be utilized in the early detection of ocular pathology, together with the presentation of appropriate slides.

Course 25
Ocular Manifestations of Systemic Diseases
Theodore Grosvenor, O.D., Ph.D.
Houston, Texas

A two-hour course—$4.00

Periods: T-2, T-3

Presentation of the effects of systemic diseases upon the eye, their effects upon innervation and motility, and their indirect effects upon vision. Special attention will be given to the role of childhood diseases.

Course 26
Recent Advances in Lighting Design
Sylvester K. Guth, E.E., D.O.S.
Cleveland, Ohio
Arthur Eastman, E.E.
Cleveland, Ohio
(By Invitation)

A two-hour course—$4.00

Periods: W-2, W-3

New information on the effect of light and lighting on the visual performance and visual comfort. The basic principles involved in providing good seeing conditions and how these principles are applied in practice will be discussed.

Course 27
Discomfort Glare
Sylvester K. Guth, E.E., D.O.S.
Cleveland, Ohio
(By Invitation)

A one-hour course—$2.00

Period: T-8

Glare sources constitute a particular problem in light adaptation owing to the restricted size of the retinal image. The role of such sources and the pupil and vision discomfort as well as the responsibility of the optometrist in providing relief will be considered.

Course 28
Night Vision
Gordon G. Heath, O.D., Ph.D.
Bloomington, Indiana

A one-hour course—$2.00

Period: F-3

Review and summary of recent research on vision in low illumination, including studies of night myopia, dark adaptation, scotopic visibility, acuity, color recognition, visual field changes, and glare, dazzle, and contrast problems in night driving.

Course 29
Space Myopia
Gordon G. Heath, O.D., Ph.D.
Bloomington, Indiana

A two-hour course—$4.00

Periods: T-10, T-11

Characteristics of refractive changes in an empty visual field; comparison of space myopia to night myopia; review of theories of causal factors, investigative methods, and results of recent research studies.

Course 30
Electronic and Conventional Tonometry
Frederick W. Hebbard, O.D., Ph.D.
Columbus, Ohio
Timothy Q. Kime, O.D.
Toledo, Ohio

A three-hour course—$6.00

Periods: T-4, T-5
(Laboratory to be arranged)

Theory and practice of the new electronic tonometer and conventional tonometers in the detection of glaucoma. Each participant will have an opportunity to use the Mackay-Marg electronic tonometer on the unanesthetized cornea and sclera, and Schiotz tonometers on the unanesthetized sclera. Attendance limited.

Course 31
Refractive Changes Throughout Life
Monroe J. Hirsch, O.D., Ph.D.

Ojai, California

A two-hour course—$4.00

Periods: T-2, T-3

Data on the expected refractive changes with age will be presented with special emphasis on the value of these data in clinical practice.

Course 32
Vision of the Aging Patient
Monroe J. Hirsch, O.D., Ph.D.
Ojai, California
Ralph E. Wick, O.D.
Rapid City, South Dakota

A two-hour course—$4.00

Period: W-E

The lecturers are co-editors of the text on *Vision of the Aging Patient*. The course will be based upon the text and will be a review of the contributions of the fifteen authorities who authored it.

Course 33
Vision Certificate Procedures and Application
H. W. Hofstetter, Ph.D.
Bloomington, Indiana

A one-hour course—$2.00

Period: F-1

Description of clinical and office techniques for processing the Vision Information Program certificates, with a discussion of their use in referrals, industrial vision program, school care programs, and other special functions.

Course 34
Patient Counseling
Louis Jaques, O.D.
Los Angeles, California

A one-hour course—$2.00

Period: F-11

How to direct attention to gain interest in and create a desire for the value of the professional work being administered. How to meet the needs and gain valuable recognition and professional acceptance.

Course 35
Binocular Equalization Tests
Louis Jaques, O.D.
Los Angeles, California

A one-hour course—$2.00

Period: F-10

Techniques for testing the refractive correction of each eye separately at the near point under conditions of binocular vision. The design of a system to implement a test will be described and the significance of the measurements discussed.

Course 36
Palpebral Aperture Contact Lenses
George N. Jessen, O.D.
Chicago, Illinois
Arthur M. Mandel, O.D.
Chicago, Illinois
Assisted by Miss Mary Smeros and Mrs. Marge Behrens

A two-hour course—$4.00

Periods: W-8, W-9

Techniques of fitting contact lenses completely contained within the palpebral aperture will be discussed and demonstrated. A candidate will be fitted with spherical and cylindrical lenses.

Course 37
Multifocal Contact Lenses
George N. Jessen, O.D.
Chicago, Illinois
Arthur M. Mandel, O.D.
Chicago, Illinois
Assisted by Miss Mary Smeros and Mrs. Marjorie Behrens

A two-hour course—$4.00

Periods: W-4, W-5

Techniques of fitting multifocal contact lenses, completely contained within palpebral aperture, will be discussed and demonstrated. Two candidates will be fitted to demonstrate clinical problems and their solutions.

TWENTY TWO 2622 Podany 5323 8-1

Course 38
Analysis and Use of Blended Bifocals
Henry A. Knoll, Ph.D.
Rochester, New York

A one-hour course—$2.00

Period: T-8

A number of blended bifocals will be described. Methods of analysis will be described and demonstrated. Samples will be made available for inspection.

Course 39
Roles of Base Curves in Refractive Corrections
Henry A. Knoll, Ph.D.
Rochester, New York

A one-hour course—$2.00

Period: F-9

Selection of base curves to minimize lens aberrations is only one of several reasons for base curve specification. Other factors will be discussed and illustrated.

Course 40
Writing of Optometric Papers
Carel C. Koch, O.D.
Minneapolis, Minnesota

Monroe J. Hirsch, O.D., Ph.D.
Ojai, California
A two-hour course—$4.00
Periods: W-10, W-11

This course by the editor and associate editor of the *Am. J. Optom. and Arch. Amer. Acad. Optom.* is a review of the fundamentals of scientific writing. It is designed for the practicing optometrist who wishes to express himself in print but requires information about style, form, etc.

Course 41
Fenestration and Multiple Micro-Holes in Corneal Contact Lenses
Donald R. Korb, O.D.
Boston, Massachusetts
A two-hour course—$4.00
Periods: F-12, F-1

The theory and clinical aspects of corneal fenestration, emphasizing the application of microscopic holes to contact lens problems. Laboratory portion includes inspection procedures and clinical demonstrations.

Course 42
Vertical Heterophorias
J. Donald Kratz, O.D.
Souderton, Pennsylvania
A one-hour course—$2.00
Period: F-9

A discussion of vertical heterophoria with emphasis on the differentiation of the concomitant and noncomitant types. A careful analysis of the methods of handling the progressive and stationary noncomitant types will be presented.

Course 43
Contact Lens Hygiene
Joseph Z. Krezanoski, Ph.D.
Sunnyvale, California
(By Invitation)
A one-hour course—$2.00
Period: T-2

A significant number of problems in the wearing of contact lenses can be traced to inadequate contact lens hygiene. Such problems will be reviewed and procedures described for avoiding them.

Course 44
Recent Advances — The Role of the Retina
Leo E. Lipetz, Ph.D.
Columbus, Ohio
A two-hour course—$4.00
Periods: F-4, F-5

A discussion of recent advances in electrophysiology, chemistry, physics, and electron microscopy, and their findings as to retinal functions.

Course 45
Visual Training of the Binocular Case
Leo Manas, O.D.
Chicago, Illinois
A two-hour course—$4.00
Periods: W-8, W-9

A program of simplified home visual training and office training using a refractor for binocular cases having high heterophorias with low fusional reserves.

Course 46
Corneal Topography
Robert B. Mandell, O.D., Ph.D.
Los Angeles, California
A two-hour course—$4.00
Periods: T-2, T-3

The validity and reliability of the measurements of peripheral corneal curvature with the keratometer and the problems of geometrical duplication of corneal topography.

Course 47
Recent Advances in Ocular Motility
Marshall V. Mark, O.D.
Boston, Massachusetts
A four-hour course—$8.00
Periods: T-E, F-E

Illustrated lectures and demonstrations of the latest diagnostic and therapeutic techniques concerned with the extraocular muscles. The subject matter has important practical application and is based on clinical experience. The most important aspects of the physiology and the pathologic physiology of the extrinsic muscles will be included. The step-by-step procedures of diagnosis will be discussed in detail.

Course 48
Ocular Manifestations of Diseases of the Central Nervous System
Marshall V. Mark, O.D.
Boston, Massachusetts
A two-hour course—$4.00
Periods: F-8, F-9

The important ocular signs, symptoms and complaints of central nervous system pathology will be discussed. Basic office procedure will be presented for diagnosing these conditions where they exist.

Course 49
Slit Lamp Microscopy in Contact Lens Fitting
Bernard Mazow, O.D.
Coral Gables, Florida
A two-hour course—$4.00
Periods: F-E

A brief review of the fundamentals of Slit

Lamp Microscopy followed by the use of the instrument in the determination of fit, and the inspection of contact lenses. A fair working knowledge of biomicroscopy is required. Attendance limited.

Course 50
Biomicroscopic Appearances of the Anterior Segment of the Eye in Pathology
Bernard Mazow, O.D.
Coral Gables, Florida
A two-hour course—$4.00
Periods: F-10, F-11

A brief review of the fundamentals of Slit Lamp Microscopy followed by a discussion, profusely illustrated with colored slides, of various pathological conditions observed with the Slit Lamp. This is directed toward the detection and diagnosis of many pathological conditions, especially of the cornea, iris and crystalline lens. A fair working knowledge of biomicroscopy is required.

Course 51
An Introduction to Slit Lamp Microscopy
Bernard Mazow, O.D.
Coral Gables, Florida
A five-hour course—$20.00
Periods: W-E, T-7, T-E

Various types of illumination, magnification, and use of the instrument. This course is designed especially for the beginner in this field. This is a combined lecture and laboratory course. (Enrollment limited to 12 in each section.)

Course 52
Amblyopia — Detection and Treatment
Earl Miller II, O.D., Ph.D., Lt., U.S.N.
Pensacola, Florida
A one-hour course—$2.00
Period: F-8

Discussion of the etiology of amblyopia, with emphasis on research. Methods of differentiating trainable cases: critical review of available orthoptic procedures for treating amblyopia.

Course 53
Surgery in Strabismus
Meredith W. Morgan, O.D., Ph.D.
Berkeley, California
A two-hour course—$4.00
Periods: W-12, W-1

The role of surgery in the treatment of strabismus, with emphasis on its coordination with other methods of treatment.

Course 54
Turville Infinity Balance Test
Meredith W. Morgan, O.D., Ph.D.
Berkeley, California
A two-hour course—$4.00
Periods: T-12, T-1

The Turville infinity binocular balance technique for determining the subjective refractive error of each eye while maintaining single binocular vision will be demonstrated. The utilization of the method, frequently referred to as the TIB technique, will be discussed. The prescribing of base-in and vertical prisms will be described.

Course 55
Ophthalmic Prisms
Meredith W. Morgan, O.D., Ph.D.
Berkeley, California
A three-hour course—$6.00
Periods: W-7, W-E

Brief discussion of the distortions created by ophthalmic prisms. Various useful methods for the prescribing of prisms will be presented.

Course 56
Pleoptics
Meredith W. Morgan, O.D., Ph.D.
Berkeley, California
A two-hour course—$4.00
Periods: W-8, W-9

Summary of methods used by Bangerter in training amblyopic subjects. Certain modifications will be suggested to make the method applicable in the average office using inexpensive equipment. A brief discussion of eccentric fixation will be given.

Course 57
Astigmatism and Contact Lenses
Harold I. Moss, O.D.
Wilmington, Delaware
A one-hour course—$2.00
Period: F-9

Irregular, residual and induced astigmatism as it applies to contact lens practice. The application of corneal and haptic lenses in correction.

Course 58
Bifocal Contact Lenses
Harold I. Moss, O.D.
Wilmington, Delaware
A one-hour course—$2.00
Period: F-4

Presentation and evaluation of the various designs of bifocal contact lenses, and suggestions relative to fitting them.

Course 59
Corneal Contours in Contact Lens Practice
Harold I. Moss, O.D.
Wilmington, Delaware

A one-hour course—$2.00
Period: F-8

Recent data on corneal contours: particular attention will be given to the role of this data in the design of the base and peripheral curves of a corneal lens. The significance and causes of corneal exhaustion also will be included.

Course 60
Contact Lenses for the Athlete
Harold I. Moss, O.D.
Wilmington, Delaware
A one-hour course—$2.00
Period: F-5

Participation in various sports frequently requires the fitting of specially designed corneal contact lenses for maximum use. These will be reviewed and recommendations for fitting will be made.

Course 61
Minimal Pressure Method of Fitting Contact Lenses
Herbert L. Moss, O.D.
Woodbridge, New Jersey
A one-hour course—$2.00
Period: T-9

A method of fitting contact lenses which rest partially on the sclera and distributes the pressure equally over most of the cornea will be described in detail. Fluorescein patterns demonstrated.

Course 62
Office Modification of Contact Lenses
Herbert L. Moss, O.D.
Woodbridge, New Jersey
A one-hour course—$2.00
Period: F-2

A precise office modification method of reducing diameters, polishing edges, altering secondary curves and repolishing surfaces on diamond tools and wax polishers will be demonstrated.

Course 63
Technique of Microlens Fitting
John C. Neill, O.D.
Philadelphia, Pennsylvania
and Associates
A six-hour course—$24.00
Periods: W-10, W-11, T-10, T-11, F-10, F-11

Lectures and practical work in the clinical fitting of patients with microlenses. Attendance limited.

Course 64
Dark Adaptation
Donald G. Pitts, M.Sc., O.D., Capt., U.S.A.F.
Wright-Patterson Air Force Base, Ohio
A two-hour course—$4.00
Periods: W-12, W-1

Various factors which affect dark adaptation of the human eye, with emphasis on the role of the transmittance of the various media.

Course 65
Adjustment and Modification of Contact Lenses
William Policoff, O.D.
Wilkes-Barre, Pennsylvania
and Associates
A six-hour course—$24.00
Periods: W-2, W-3, T-2, T-3, F-2, F-3

A laboratory course covering the following subjects: Changing diameter of lenses, refinishing edge of lens, reducing optical zone, changing peripheral radius on concave side of lens, reducing edge thickness of lens, removing fine surface scratches from convex and concave surface of lens, conlish edge finishing, grinding toric bevels, drilling and grinding apertures in contact lenses. Attendance limited.

Course 66
Simple Procedures for Designing Iseikonic Lenses
Arline W. Rayner, B.Sc.
Southbridge, Massachusetts
(By Invitation)
A two-hour course—$4.00
Period: T-E

Aimed at those corrections which can be furnished by non-bitoric lenses ground from standard blanks in local laboratories. Interpretation of eikonometer readings and test lens set-up will be discussed. Recommended for beginners and for review.

Course 67
Comprehensive Course on the Design of Aniseikonic Corrections
Arline W. Rayner, B.Sc.
Southbridge, Massachusetts
(By Invitation)
A two-hour course—$4.00
Periods: F-E

Translation procedures useful when an aniseikonic correction necessitates bitoric lenses. Charts and tables will simplify the design work. Recommended for those with some previous background in iseikonic translations.

Course 68
Visual Screening Procedures
Alfred A. Rosenbloom, Jr., O.D.

Chicago, Illinois
A two-hour course—$4.00
Periods: W-10, W-11

Purposes of visual screening, characteristics evaluated by visual screening tests, currently available screening instruments, criteria and interpretation of findings for referral are considered. The implications and significance of the screening procedures as they relate to discussion with parents, school nurse, and educators will be reviewed.

Course 69
Subnormal Vision
Alfred A. Rosenbloom, Jr., O.D.
Chicago, Illinois
William Policoff, O.D.
Wilkes-Barre, Pennsylvania
A four-hour course—$8.00
Periods: W-E, T-E

All aspects of the problem are considered, including definition, causes, psychological factors, patient selection, examination techniques, considerations in selecting the appropriate visual aid, and adaptive training procedures. Both the problems of the education and of the rehabilitation of the partially blind person will be considered. The course will include a clinical demonstration of examination techniques.

Course 70
Headaches of Ocular Origin
Raymond R. Roy, O.D.
Portland, Oregon
A two-hour course—$4.00
Periods: F-E

Physiology of headaches, case history, symptoms as an aid in diagnosis, and discussion of ocular migraine.

Course 71
Prolonged Occlusion Testing
Raymond R. Roy, O.D.
Portland, Oregon
A two-hour course—$4.00
Periods: T-E

Fusional demand often masks a significant binocular dysfunction. For diagnosis, adequate binocular tests must be used. The use and results of prolonged occlusion will be presented.

Course 72
Stereopsis
Max Schapero, O.D.
Los Angeles, California
A one-hour course—$2.00
Period: F-3

Theoretical and clinical considerations of stereopsis, development, role in depth perception, methods of testing especially with a stereoscope, and visual training procedures for improvement.

Course 73
Ocular Pathology Review Organized by the Section on Pathology
Arthur Shlaifer, O.D., Ph.D., Chairman
Philadelphia, Pennsylvania
A four-hour course—$8.00
Periods: T-4, T-5, F-1, F-2

An illustrated review of ocular pathology of primary importance to the optometrist from the standpoint of incidence and significance.

Course 74
Visual Fields with Multi-Pattern Test Targets
Arthur Shlaifer, O.D., Ph.D.
Philadelphia, Pennsylvania
A one-hour course—$2.00
Period: F-8

Discussion and demonstration of multiple-pattern visual field screening techniques using tachistoscopic presentation of targets. Consideration of advantages and limitations of such techniques, particularly with regard to the detection of glaucoma.

Course 75
Techniques of Fitting a Ptosis Crutch
Paul F. Shulman, O.D.
Chicago, Illinois
A two-hour course—$4.00
Periods: F-E

The methods of measuring and fitting a patient with a ptosis crutch will be demonstrated. Various forms of ptosis crutches will be exhibited and slides of "before—after" fittings will be shown. Instruction material will be distributed.

Course 76
Space Eikonometer Technique of Measuring Aniseikonia
Donald A. Springer, O.D.
Anniston, Alabama
A one-hour course—$2.00
Period: T-3

This course will be devoted to the step-by-step procedure of measuring aniseikonia with the Space Eikonometer. The presentation will include not only the technique for usual patients, but also for more complicated cases which have difficulty in making reliable responses. The subject material will be essentially practical and based upon actual clinical experience. Specific questions germane to the technique of measuring aniseikonia will be discussed during the course. Attendance limited.

Course 77
Contact Lens Solutions — Their Rationale and Use
Ivan J. Szekely, Ph.D.
Sunnyvale, California
(By Invitation)
A two-hour course—$4.00
Periods: T-12, T-1

The use of contact lens solutions (wetting agents, hydrating solutions, decongestants and diagnostic aids) will be discussed. Physical-chemical aspects of formulation of these solutions as it relates to the physiology of the eye will be presented with particular emphasis on the hygienic care of contact lenses. Illustrative demonstrations will be provided.

Course 78
Use of New Plastics in Fitting Spectacle Frames and Inspecting Contact Lenses
Akiri Tajiri, O.D.
Reedley, California
A two-hour course—$4.00
Periods: W-2, W-3

Discussion and demonstration of the use of molding plastic in the custom fitting of bridges and temples of spectacle frames. Also a demonstration of a related technique for the accurate inspection of contours and edges of contact lenses.

Course 79
Toric Corneal Lenses
Evart Warren, O.D.
Washington, D. C.
A two-hour course—$4.00
Periods: W-4, W-5

Residual astigmatism with conventional spherical corneal lenses can be corrected by use of toric corneal lenses. The theory and practical implications of such corrections will be reviewed; case studies also will be presented and illustrated by colored slides.

Course 80
Formation and Drainage of Aqueous Humor
Bradford W. Wild, O.D., Ph.D.
Columbus 10, Ohio
A one-hour course—$2.00
Period: F-12

Current research concerning the formation and drainage of aqueous humor will be presented. Factors that cause increased intraocular pressure and current practices for their control will also be considered.

Course 81
Quality Control of Contact Lenses
Bradford W. Wild, O.D., Ph.D.
Columbus 10, Ohio
A one-hour course—$2.00
Period: F-1

A review of the basic variables in contact lens manufacture. Means of measuring and evaluating these variables will be given. Common lens defects will be demonstrated and explained.

Course 82
The Effect of Contact Lenses on Corneal Physiology
Bradford W. Wild, O.D., Ph.D.
Columbus, Ohio
A two-hour course—$4.00
Periods: F-4, F-5

The physiology of the normal cornea and the influence of contact lenses upon corneal function. Consideration will be given to corneal sensitivity and the development of haze and halo (Sattler's Veil).

Course 83
Orthoptics
John Zettel, Jr., O.D.
Cincinnati, Ohio
A two-hour course—$4.00
Periods: W-4, W-5

Beginning an orthoptics practice; application of orthoptics; role of advanced orthoptics techniques such as pleoptics.

CONDENSED SCHEDULE OF COURSES

Course	*Instructor*	*Subject*	*Hours*	*Periods*
1	Allen	Analysis of Problems of Retinoscopy, $4.00	2	T-4, T-5
2	Allen	Efficiency and the Optometric Eye Examination, $4.00	2	F-4, F-5
3	Anapolle	Rapid Reading for Adults, $12.00	3	F-10, F-11, F-12
4	Anapolle	Home Visual Training, $4.00	2	W-2, W-3
5	Arner	Optics of Contact Lenses, $4.00	2	W-12, W-1
6	Baldwin	Contact Lens Symptomotology, $2.00	1	F-10

Course	Instructor	Subject	Hours	Periods
7	Baldwin	Headaches—Mechanisms and Syndromes. $2.00	1	F-11
8	Bebber	Accounting and Office Procedure. $4.00	2	W-8, W-9
9	Bing	Reading Readiness. $4.00	2	W-4, W-5
10	Bing	Reading Disability. $4.00	2	T-10, T-11
11	Braff	Impression Fitting of Contact Lenses. $6.00	3	W-12, W-1, T-1
12	Copeland	Streak Retinoscopy. $8.00	4	W-10, W-11, T-10, T-11
13	Davis	Aspheric Lenses—Design and Use. $2.00	1	F-12
14	Dick	Accounts Receivable Control. $2.00	1	T-9
15	Dick	Practice Management. $4.00	2	W-E
16	Eakin	Ophthalmic Dispensing and Mechanics. $4.00	2	T-12, T-1
17	Feinbloom, Williams & Hopping	Sub-normal Vision and Clinic. $8.00	4	W-2, W-3, T-4, T-5
18	Feinbloom	The Physiological Optics of the Partially Blind Eye. $4.00	2	F-2, F-3
19	Giglio	Visual Manifestations of Brain Tumors and Lesions. $4.00	2	F-2, F-3
20	Graham & Associates	Advanced Course on Corneal Lenses. $8.00	4	W-10, W-11, T-10, T-11
21	Gregg & Sugg	Optometric Writing. $2.00	1	T-8
22	Gregg & Sugg	Effective Public Relations for an Optometric Office. $2.00	1	T-9
23	Gregg & Sugg	Optometric Public Speaking	1	T-12
24	Grosvenor	Early Detection of Ocular Pathology. $4.00	2	T-8, T-9
25	Grosvenor	Ocular Manifestations of Systemic Diseases. $4.00	2	T-2, T-3
26	Guth	Recent Advances in Lighting Designs. $4.00	2	W-2, W-3
27	Guth	Discomfort Glare. $2.00	1	T-8
28	Heath	Night Vision. $2.00	1	F-3
29	Heath	Space Myopia. $4.00	2	T-10, T-11
30	Hebbard & Kime	Electronic and Conventional Tonometry. $6.00	3	T-4, T-5
31	Hirsch	Refractive Changes Throughout Life. $4.00	2	T-2, T-3
32	Hirsch & Wick	Vision of the Aging Patient. $4.00	2	W-E
33	Hofstetter	Vision Certificate Procedures and Application. $2.00	1	F-1
34	Jaques	Patient Counseling. $2.00	1	F-11
35	Jaques	Binocular Equalization Tests. $2.00	1	F-10
36	Jessen & Mandel	Palpebral Aperture Contact Lenses. $4.00	2	W-8, W-9
37	Jessen & Mandel	Multifocal Contact Lenses. $4.00	2	W-4, W-5
38	Knoll	Analysis and Use of Blended Bifocals. $2.00	1	T-8
39	Knoll	Roles of Base Curves in Refractive Corrections. $2.00	1	F-9
40	Koch & Hirsch	Writing of Optometric Papers. $4.00	2	W-10, W-11
41	Korb	Fenestration and Multiple Micro-Holes in Corneal Contact Lenses. $4.00	2	F-12, F-1
42	Kratz	Vertical Heterophorias. $2.00	1	F-9
43	Krezanoski	Contact Lens Hygiene. $2.00	1	T-2
44	Lipetz	Recent Advances—The Role of the Retina. $4.00	2	F-4, F-5

Course	*Instructor*	*Subject*	*Hours*	*Periods*
45	Manas	Visual Training of the Binocular Case. $4.00	2	W-8, W-9
46	Mandell	Corneal Topography. $4.00	2	T-2, T-3
47	Mark	Recent Advances in Ocular Motility. $8.00	4	T-E, F-E
48	Mark	Ocular Manifestations of Diseases of the Central Nervous System. $4.00	2	F-8, F-9
49	Mazow	Slit Lamp Microscopy in Contact Lens Fitting. $4.00	2	F-E
50	Mazow	Biomicroscopic Appearances of the Anterior Segment of the Eye in Pathology. $4.00	2	F-10, F-11
51	Mazow	An Introduction to Slit Lamp Microscopy. $20.00	5	W-E, T-7, T-E
52	Miller	Amblyopia—Dection and Treatment. $2.00	1	F-8
53	Morgan	Surgery in Strabismus. $4.00	2	W-12, W-1
54	Morgan	Turville Infinity Balance Test. $4.00	2	T-12, T-1
55	Morgan	Ophthalmic Prisms. $6.00	3	W-7, W-E
56	Morgan	Pleoptics. $4.00	2	W-8, W-9
57	Moss	Astigmatism and Contact Lenses. $2.00	1	F-9
58	Moss	Bifocal Contact Lenses. $2.00	1	F-4
59	Moss	Corneal Contours in Contact Lens Practice. $2.00	1	F-8
60	Moss	Contact Lenses for the Athlete. $2.00	1	F-5
61	Moss	Minimal Pressure Method of Fitting Contact Lenses. $2.00	1	T-9
62	Moss	Office Modification of Contact Lenses. $2.00	1	F-2
63	Neill	Technique of Microlens Fitting. $24.00	6	W-10, W-11, T-10, T-11, F-10, F-11
64	Pitts	Dark Adaptation. $4.00	2	W-12, W-1
65	Policoff	Adjustment and Modification of Contact Lenses. $24.00	6	W-2, W-3, T-2, T-3, F-2, F-3
66	Rayner	Designing Iseikonic Lenses. $4.00	2	T-E
67	Rayner	Design of Aniseikonic Corrections. $4.00	2	F-E
68	Rosenbloom	Visual Screening Procedures. $4.00	2	W-10, W-11
69	Rosenbloom & Policoff	Subnormal Vision. $8.00	4	W-E, T-E
70	Roy	Headaches of Ocular Origin. $4.00	2	F-E
71	Roy	Prolonged Occlusion Testing. $4.00	2	T-E
72	Schapero	Stereopsis. $2.00	1	F-3
73	Shlaifer	Pathology Review. $8.00	4	T-4, T-5, F-1, F-2
74	Shlaifer	Visual Fields. $2.00	1	F-8
75	Shulman	Fitting of Ptosis Crutch. $4.00	2	F-E
76	Springer	Space Eikonometer Technique of Measuring Aniseikonia. $2.00	1	T-3
77	Szekely	Contact Lens Solutions—Their Rationale and Use. $4.00	2	T-12, T-1
78	Tajiri	Use of New Plastics in Fitting Spectacle Frames and Inspecting Contact Lenses. $4.00	2	W-2, W-3
79	Warren	Toric Corneal Lenses. $4.00	2	W-4, W-5
80	Wild	Formation and Drainage of Aqueous Humor. $2.00	1	F-12
81	Wild	Quality Control of Contact Lenses. $2.00	1	F-1
82	Wild	Effect of Contact Lenses on Corneal Physiology. $4.00	2	F-4, F-5
83	Zettel	Orthoptics. $4.00	2	W-4, W-5

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FORM FOR ADVANCE REGISTRATION

AMERICAN ACADEMY OF OPTOMETRY
CHICAGO, DECEMBER 6, 7, 8, 1961
DRAKE HOTEL

Application for advance registration and tickets for courses should be made to the American Academy of Optometry, 1506-1508 Foshay Tower, Minneapolis 2, Minnesota.

The entire fee for each course must accompany the application. All persons enrolled in courses must have tickets, purchased either through advance registration or at the registration desk. Without tickets no one will be admitted.

All tickets ordered through advance registration will be mailed to the purchaser on receipt of order. For those courses with limited attendance, if the tickets are sold out, money will be returned.

Advance Order Sheet

Please list all Courses you wish to take.

Course No.	Name of Instructor	Fee
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
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_____	_____	_____
_____	_____	_____

(Use additional sheet if necessary)

Total fee enclosed _____

Name of Applicant _____

Address _____

City _____ Zone _____ State _____

(Also enclose professional card or letterhead)

Members of the American Academy of Optometry are expected to attend the four day meeting of the Academy which immediately follows the Post-Graduate Courses.

Other optometrists enrolling in the Post-Graduate Course Program who also wish to attend the Annual Meeting of the Academy check here for invitation. ☐

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SPECIAL REPORT

A MODEL CLINICAL PROGRAM FOR OPTOMETRIC STUDENTS*

Margaret Dowaliby†
Los Angeles College of Optometry
Los Angeles, California

The foremost aim of a professional college is the adequate training of its students in the performance of the services which the field entails. It is accepted that stress must be and is placed on the basic theoretical factors involved. It should be equally obvious that understanding basic theory is merely a beginning. While it is the foundation of a profession, a foundation without an adequate structure will not serve its original purpose. In a professional college that structure is the clinical aspects of the profession. Unless the practical applications of a prifession are understood the student will not become the kind of prifessional man who contributes the ultimate to his patient's welfare.

To arrive at a decision as to the best type of clinical program one must evaluate the desired goals. Obviously it must attempt to translate classroom knowledge to clinical proficiency in the performance of the diagnostic tests involved. But is this the only aim of a teaching clinical program in a health profession? Does a professional man fulfill his duty to society when he becomes competent only in the testing and diagnostic procedures of his profession?

It requires but a glance through the literature of the optometric profession in the past few years to see the spot-lighting of another clinical aspect. Because of the tremendous technical strides in the fields of optometry, one important fact stands out so prominently it cannot be ignored. The performance of a professional service is strongly tied in with the emotions of the patient. Divorcing the two is an impossibility. Understanding the patient's reaction to his problem and to the health services rendered is as important as the problem itself. If educators do not place as strong an emphasis on the psychological aspects of a profession as they do the technical aspects a great injustice is done

*Read before the annual meeting of the American Academy of Optometry, San Francisco, Calif., December 11, 1960. For publication in the August, 1961, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

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to the student and his future patients. Each patient experiences some anxiety when the need for a health service arises. His feelings are important to the professional man for they play as important a role in his reaction to the services rendered as do the completeness of the tests performed and the accuracy of the diagnosis.

Another obligation of a health profession college is to teach the student that his patient's welfare must be foremost. The student must be able to become emotionally involved enough that he can learn what it means to assume responsibility for his patient. The college must teach him the importance of establishing rapport with his patient so that he will be professionally accepted and his judgment respected. While these truths can be verbalized in a classroom environment, the full impact of their meaning cannot be realized until the student is placed in a position to experience their need for himself. And this must be done through the clinical program of a professional college.

What I have said so far is to prepare you philosophically for the ultimate goal in a clinical program for optometric students. This type of clinical program is not necessarily original with me. Much of it is based on my twelve years of experience as a Clinical Supervisor at the Los Angeles College of Optometry. Programs of this nature are in operation at many top-level medical and dental schools. Some of our optometry colleges have comparable programs beyond the planning stage and are utilizing some or all of the proposed recommendations. This paper has been prepared in the hope that the importance and significance of these recommendations may be obvious enough that all optometric educators will consider and incorporate the proposed changes into their clinical programs. I strongly feel this type of clinical schedule is the best training a student can have for his future role as a Doctor of Optometry.

The ideal clinical program has one main characteristic—one student *must* perform *all* of the optometric services for an assigned patient under the constant supervision of a staff optometrist. The patient is not shifted from student to student nor from student to staff. This applies regardless of the type and extent of the optometric services necessary, whether it be a refraction alone or refraction, dispensing, visual fields, contact lenses, visual training, etc. The goals can be achieved only when the student understands that the welfare of a specific patient is his complete responsibility.

Perhaps the best way to explain this student-training program is to follow the services performed for a patient through an optometric clinic where this plan is in effect. We will assume the patient is in need

of a refraction and new spectacles. When the patient registers he is assigned to a student with the understanding that the student is his personal optometrist. This allows for a patient-doctor relationship that is often impossible if the patient felt the student was just to be tolerated until the staff member took over his case. Upon completion of the refraction, the student decides upon the prescription by consultation with the staff. While a staff member does not "take over" the patient, he may wish to check certain findings and/or have the student do additional tests. In the final analysis, however, the student himself decides upon the type of optometric care for the patient. What has been accomplished?

The student knowing that the final decision is his, is motivated sufficiently to study more carefully his findings in order to justify his course of action. Students' decisions, however, must be followed up and if a prescription has been written the student must meet the patient within a specified time to check his progress.

Next the student dispenses the material to his patient. Aware of the responsibility of having to do this, the student will have taken an adequate dispensing history and therefore will have a good idea of his patient's dispensing needs (type of frame, type of lenses, etc.). Not only will he be able to gain the experience of taking the facial measurements but he learns patient control in the dispensing room. This is almost impossible to achieve without the rapport that already has been established. Patient control where the patient has some understanding of the services involved, and personal wishes which must be satisfied, is so different from patient control in the refracting room. It must be learned by doing and experience. The dispensing findings are checked by a staff optometrist. Before the patient is dismissed he is advised if any questions arise he is to call his student-doctor directly.

The student next orders any necessary materials from an optical laboratory. The written order is verified for accuracy and completeness, again by the staff. It is now the student's responsibility to see that the materials arrive within a reasonable length of time and that his order has been filled accurately. In this way he learns first-hand the type of personal relationship he can expect to have with an optical laboratory and the quality of service he can expect or demand.

After the materials arrive, the student calls his patient for a return appointment. At this time he performs any necessary optometric service whether it be inserting new lenses into the patient's spectacle frame or adjusting the new pair of spectacles. He observes first-hand the patient's reaction to the lenses and to the cosmetic effect of the selected

eyewear. The patient is seen by a staff optometrist before dismissal and is again instructed to call the student directly if any problems arise (difficulty in getting used to prescription, adjustment unsatisfactory, etc.). Thus, the student learns if his actions are questioned by the patient. He is not told in a classroom environment where much of the impact of the patient's words is lost in the retelling situation.

If the patient requires contact lenses, a one-student type of clinical program has even greater value. It is becoming increasingly obvious that one reason for contact lens failures is the inability of the patient to adjust emotionally to the lenses. The successful patient is the one who is able to "lean" on some one person who is technically competent, but equally as important, personally interested. It is of utmost importance that the student be given the opportunity to observe this phenomenon directly.

This type of clinical program sounds like the "ideal" to many educators. Why, then, is it not utilized in all of the optometric colleges? There are two main problems. The first concerns curriculum. In most optometric colleges the student spends the greater part of the first year studying theoretical background courses. Most of the practical courses are scheduled in the student's final year. This is the same time he is assigned to clinic responsibilities. This traditional pattern has to be revised so the student will have completed most of his practical courses in the year preceding graduation. Otherwise he will be limited in his ability to perform all of the optometric services outlined. The clinical program will not be workable. Some medical colleges have handled this problem by introducing a number of practical courses in the student's first year which was devoted previously, almost exclusively to theory and background courses.

Optometric curricula will not only have to be revised but updated. It is assumed the student receives *all* of the necessary technical and practical knowledge necessary to a profession in a classroom environment. Unfortunately this is not always true. For example, "Ophthalmic Dispensing," a subject it is my responsibility to teach at the Los Angeles College of Optometry involves services I would estimate takes 50% of the average optometrist's office time (measurements, selecting frames, delivery, future adjusting). It is, I believe, passed over lightly in some schools. Few even give the course the recognition it deserves by entitling it "Ophthalmic Dispensing" but cover the involved material in a relatively small amount of classroom time in the "Ophthalmic Optics" courses. Under the clinical program I am proposing, this would have to be modified. The student would be exposed to this phase of

optometry to the degree that it will adequately cover his clinical needs.

The other major problem involves the amount of free time available to the last year student so he may schedule his patients in such a manner that he can perform all of the necessary optometric services. The University of Southern California's Dental College solved the problem by limiting senior classroom courses from 8:00 to 10:00 A.M. The rest of the school day is free for clinical work. To insure that students utilize this time properly, basic minimums of case types are previously determined and must be fulfilled before graduation is possible.

It has been said an optometric student does not need such a complete clinic program because he can "pick up" all of its benefits with experience after graduation. I say we are doing our profession and the student a grave injustice to take this attitude. Students frequently graduate feeling they must have more practical experience before venturing into private practice. Frankly, some of them will work where they can get this experience whether or not it is in a professional environment. Thus our schools help perpetuate a mode of practice we denounce because the clinical aspects of the profession are not "drilled" as deeply into the student as the theoretical aspects.

Just as frankly, it is not the problem of teaching the student to master the technical aspects of optometry that bothers me. It is equally as important for the student to be taught what it means to hold a doctorate in one of the health professions. He must be aware of the responsibility that goes with his degree. He must be given the opportunity to experience the warmth that is felt as the result of an optometric job well-done. Equally important, he should be taught the situations he must conquer to earn the respect and affection of his patients.

To allow the student to go through school inadequately trained, technically or emotionally, unaware of the problems he will encounter in private practice, is to do him a great disservice. Optometry, as any profession, has its pitfalls. They are seldom in the neutralization of a reflex or in the turning of a flip-cylinder. They are in the emotional reactions of the patients to optometric services and in the performing of almost menial services to the satisfaction of the patient. And too often these are passed over or ignored in a classroom environment. It is only by exposing the student to this and helping him to solve his problems that we can graduate the best Doctor of Optometry optometric education can produce.

Of course, I realize the amount of work that must be done to make such a clinical program work. But we in optometry have the edu-

cational know-how to work this program properly. We will do so when its importance is realized. And realized it must be; for in our students lie our dreams for optometry's future. Without them we have no tomorrow. We must give them firm roots by adequately teaching each one what it means to hold the proud title, "Doctor of Optometry."

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ANNOUNCEMENT

THE OHIO STATE UNIVERSITY COURSE IN GLAUCOMA DETECTION

Dr. Herbert G. Mote, supervisor of postgraduate courses at The Ohio State University School of Optometry, announces that the School will present a course in glaucoma detection, for practicing optometrists, from Monday afternoon, September 11, 1961 to Thursday noon, September 14, 1961. The principal instructor will be Frederick W. Hebbard, O.D., Ph.D., of The Ohio State University faculty.

The course will be largely practical in nature and will include a thorough coverage of tonometry, including the Wolfe, Schiotz, and Mackay-Marg electronic tonometer. Laboratory sessions will enable all registrants to become familiar with the detailed operation and care of tonometers, including the procedure used in "balancing" the new electronic tonometer. In addition, participants will have an opportunity to use field screeners, flicker screeners, ultraviolet scotomatry, and other modern methods useful in detecting glaucoma. All phases of the course will be given in the recently completed Optometry Clinical Building.

The cost of the course is $50.00. In the event that registration exceeds facilities, a second course will be given at a later date. Those optometrists wishing to take the course should send $25.00 to Dr. H. G. Mote, School of Optometry, The Ohio State University, Columbus 10, Ohio. Those attending the course will receive a suitable certificate. No examinations will be given. Housing at University residence halls will be available at a reasonable cost.

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